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No. 2,557.] *FRIDAY, NOVEMBER 22, 1901.* [*Vol. L.*

ONE-HUNDRED-AND-FORTY-EIGHTH SESSION, 1901-1902.

PATRON.—HIS MOST GRACIOUS MAJESTY THE KING.

COUNCIL.

Sir Frederick Bramwell, Bart., D.C.L., F.R.S., *President of the Society.*

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SECRETARY.

Sir Henry Trueman Wood, M.A.

Assistant Secretary.—Henry B. Wheatley, F.S.A.

Assistant Secretary for the Indian and Colonial Sections.—Samuel Digby.

Chief Clerk.—George Davenport.

Accountant.—J. H. Buchanan.

Auditors.—Knox, Cropper & Co.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One-hundred-and-Forty-Eighth Session was held on Wednesday evening, the 20th of November, when an Address was delivered by Sir William Henry Preece, K.C.B., F.R.S., Chairman of the Council.

For meetings previous to Christmas the following arrangements have been made:—

ORDINARY MEETINGS.

November 27.—J. Gordon Parker, Ph.D., Director of the London Leather Industries Research Laboratories, "Leather for Bookbinding." Richard Garnett, C.B., LL.D., in the chair.

December 4.—Herbert Stone, "The Identification of Wood and its Application to Scientific and Commercial Purposes." Sir Dietrich Brandis, K.C.I.E., Ph.D., F.R.S., in the chair.

December 11.—Prof. Ernest Wilson, M.Inst.E.E., "Aluminium."

December 18.—Prof. George Forbes, F.R.S., "Range Finders."

INDIAN SECTION.

DECEMBER 5.—EDWARD PENTON, B.A.Oxon, "The New Trade Route to Persia by Nushki and Seistan." The Right Hon. SIR HENRY DRUMMOND WOLFF, G.C.B., G.C.M.G., in the chair.

Papers for meetings after Christmas :—

LIEUT.-COLONEL ROBERT E. B. CROMPTON, C.B., M.Inst.C.E., M.Inst.E.E., "The Use of Mechanical Transport for Military Purposes."

EVERARD R. CALTHROP, M.Inst.C.E., M.I.Mech.E., "Servia as a Field for Railway, Mining, and Commercial Enterprise."

PROF. ROBERTS BEAUMONT, "Recent Inventions in Weaving Machinery."

FRANK J. GRAY, Assoc. M.Inst.C.E., F.R.Met.S., "Elliptographs."

CLOUDESLEY BRERETON, "The Rural Schools of France."

SIR WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "Recent Work on the Photography of Colour."

ERIC H. STUART BRUCE, M.A., "The Use of Balloons in War."

E. PRICE-EDWARDS, of The Trinity House, "Sound Signals."

BERESFORD PITE, F.R.I.B.A., "Street Architecture."

GERALD C. HORSLEY, "Structural Colour Decoration of the Interior of Public Buildings."

REV. HERBERT THURSTON, S.J., "The History of the Rosary in all Countries."

HALSEY RICARDO, "The Use of Enamelled Tiles from an Architect's Point of View."

J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E., "London Tramways."

CLAYTON BEADLE, "Technical Education as Applied to Paper Making."

J. LEON WILLIAMS, "Remains of the Greek Occupation of Sicily."

INDIAN SECTION.

The meetings of this Section will take on Thursday Afternoons, at 4.30 o'clock :—
December 5, January 16, February 6, 27, March 13, April 17, May 1.

COLONIAL SECTION.

The meetings of this Section will take place on Tuesday Afternoons, at 4.30 o'clock :—
December 17, February 18, March 18, April 22.

APPLIED ART SECTION.

The meetings of this Section will take place on Tuesdays, at 4.30 or 8 o'clock :—
January 21, February 4, March 4, April 8, May 6, 27.

CANTOR LECTURES.

The following courses of Cantor Lectures will be delivered on Monday Evenings, at 8 o'clock :—

WILLIAM JAGO, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." Four Lectures.

November 25, December 2, 9, 16.

LECTURE I.—NOVEMBER 25.—Introduction. Division into flour confectionery and sugar confectionery—Flour confectionery—Basis, flour, varieties of—Moistened with milk and eggs—made light by aërating agents—Lightening action of eggs.
Practical Demonstration.—Fancy biscuit making.

LECTURE II.—DECEMBER 2.—Flour confectionery. Made rich by fats—Animal fats, butter, etc.—Vegetable fats—Made sweet by cane sugar, honey, malt extract.

LECTURE III.—DECEMBER 9.—Sugar confectionery—Composition and properties of sugar: cane sugar, beet sugar, glucose, maltose—Principles of sugar boiling—Various sugar working operations—Sweets, their nutritious value.
Practical Demonstration.—Sugar working and sweet making.

LECTURE IV.—DECEMBER 16.—Confectionery—flavoured by fruit, cherries, currants, raisins, nuts, walnuts, almonds; preserved fruits, jams, essential oils, lemon, orange, almonds; fruit essences; vanilla—Their composition and properties.

Practical Demonstration.—Piping and ornamentation of cakes.

[*The practical demonstrations are subject to alteration.*]

SAMUEL RIDEAL, D.Sc., F.I.C., "The Sterilisation of Water." Four Lectures.
January 13, 20, 27, February 3.

CYRIL DAVENPORT, "Jewellery." Three Lectures.
February 10, 17, 24.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.
March 3, 10, 17.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures.
April 14, 21, 28, May 5.

JUVENILE LECTURES.

Two lectures suitable for a juvenile audience will be delivered on Wednesday Afternoons, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

CONVERSAZIONE.

The Annual Conversazione of the Society will be held in June. Each member is entitled to a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department or science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

COLONIAL SECTION.—The Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies. Four or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted by signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, and Music, A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members. who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni.*

To receive a copy of the weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1901-1902. It is issued subject to any necessary alterations:—

NOVEMBER, 1901.		
1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	
14	Th	
15	F	
16	S	
17	**S**	
18	M	
19	Tu	
20	W	Opening Meeting
21	Th	
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture I. 1
26	Tu	
27	W	Ordinary Meeting
28	Th	
29	F	
30	S	

DECEMBER, 1901.		
1	**S**	
2	M	Cantor Lecture I. 2
3	Tu	
4	W	Ordinary Meeting
5	Th	Indian Section
6	F	
7	S	
8	**S**	
9	M	Cantor Lecture I. 3
10	Tu	
11	W	Ordinary Meeting
12	Th	
13	F	
14	S	
15	**S**	
16	M	Cantor Lecture I. 4
17	Tu	Colonial Section
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	Christmas Day
26	Th	*Bank Holiday*
27	F	
28	S	
29	**S**	
30	M	
31	Tu	

JANUARY, 1902.		
1	W	Juvenile Lecture I.
2	Th	
3	F	
4	S	
5	**S**	
6	M	
7	Tu	
8	W	Juvenile Lecture II.
9	Th	
10	F	
11	S	
12	**S**	
13	M	Cantor Lecture II. 1
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	**S**	
20	M	Cantor Lecture II. 2
21	Tu	Applied Art Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	Cantor Lecture II. 3
28	Tu	
29	W	Ordinary Meeting
30	Th	
31	F	

FEBRUARY, 1902.		
1	S	
2	**S**	
3	M	Cantor Lecture II. 4
4	Tu	Applied Art Section
5	W	Ordinary Meeting
6	Th	Indian Section
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture III. 1
11	Tu	
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture III. 2
18	Tu	Colonial Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	Cantor Lecture III. 3
25	Tu	
26	W	Ordinary Meeting
27	Th	Indian Section
28	F	

MARCH, 1902.		
1	S	
2	**S**	
3	M	Cantor Lecture IV. 1
4	Tu	Applied Art Section
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture IV. 2
11	Tu	
12	W	Ordinary Meeting
13	Th	Indian Section
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture IV. 3
18	Tu	Colonial Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	
25	Tu	
26	W	
27	Th	
28	F	Good Friday
29	S	
30	**S**	Easter Sunday
31	M	*Bank Holiday*

APRIL, 1902.		
1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	Applied Art Section
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture V. 1
15	Tu	
16	W	Ordinary Meeting
17	Th	Indian Section
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture V. 2
22	Tu	Colonial Section
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture V. 3
29	Tu	
30	W	Ordinary Meeting

MAY, 1902.		
1	Th	Indian Section
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture V. 4
6	Tu	Applied Art Section
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	
17	S	
18	**S**	Whit Sunday
19	M	*Bank Holiday*
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	
26	M	
27	Tu	Applied Art Section
28	W	Ordinary Meeting
29	Th	
30	F	
31	S	

JUNE, 1902.		
1	**S**	
2	M	
3	Tu	
4	W	
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	
18	W	
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	Annual General Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, and the Cantor Lectures.

The Meetings of the Indian Section and the Colonial Section will commence at Half-past Four o'clock.

The Meetings of the Applied Art Section will be held at Half-past Four or Eight o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Five o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 20, 1900; Sir William Henry Preece, K.C.B., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Aiyangar, K. Srinivasa, Assistant Engineer, P.W.D., Camp Gudwada, Madras, India.
Aiyengar, N. S. Bashyam, Little Conjeeveram, Madras, India.
Armitage, Frederick, 88, Amhurst-park, Stamford-hill, N., and Monument-station-buildings, King William-street, E.C.
Armstrong, Frank, 88 and 90, Deansgate, Manchester.
Ashton, James, Hacken Sewage Works, Moses-gate, Bolton.
Ashworth, John Jackson, Haslen-house, Handforth, Cheshire, and Faulkner-street, Manchester.
Atkinson, George, 43, Cleveland-road, Crumpsall, Manchester.
Bailey, Harry Dorning, 16, Fenchurch-street, E.C., and Sale-hall, Sale, Cheshire.
Bana, R. H., Navsari, near Surat, India.
Bankart, George B., Bromsgrove, Worcestershire.
Barker, Henry E., Accra, Gold Coast Colony, West Africa.
Barnard, Robert, Bhalgora-house, Jharia, Bengal, India.
Barralet, Edgar Stuart, 2, Green-street, Bethnal-green, E.
Barwell, Noel F., 3, Russell-chambers, Bury-street, W.C.
Bennett, Thomas Jewell, care of James Douglas, Bangor, North Wales.
Berg, H., B.Sc., Telegraph Works, Silvertown, E.
Bhargava, Prag Narain, Newul Kishore Press, Lucknow, India.
Bill, John Hugo Hepburn, Multan, Punjab, India.
Bingham, Herbert, Drayton - street, Leichhardt, Sydney, New South Wales, Australia.
Breckinridge, Cabell, Danville, Kentucky, U.S.A.
Broome, Joseph, Bayonne, New Jersey, U.S.A.
Brown, James, Park-lodge, Rawal Pindi, India.
Burgess, Alfred, The Motor Manufacturing Co., 47, Holborn-viaduct, E.C.
Calvert, Richard, J.P., Walton-house, Walton-le-Dale, near Preston.
Campos Novaes, Dr. José de Estacao da Capoeira Grande, Ramal Ferreo Campineiro, Estado de Sao Paulo, Campinas, Brazil, South America.
Carter, Captain John Robert Blackall Graham, I.S.C., Songad, Kathiawar, Bombay, India.
Carter, Owen, Wykeham, Poole.
Chalmers, William James, 1428, Marquette-building, Chicago, U.S.A.
Chatterjee, Abinash Chandra, B.A., 12-3 and 12-4, Pataldanga-street, Calcutta, India.
Chesterman, William, Belmayne, Sheffield.
Chivers, Cedric, Portway, Bath.
Clyburn, William Douglas, Baghitand, Koderma, Hazaribagh, Bengal, India.
Cooch-Behar, His Highness the Maharajah Bhup Bahadur of, Darjeeling, India.
Cook, William Henry, Cotham-house, West-hill, Huddersfield.
Cooper, William, 1, Bonnington-terrace, Edinburgh.
Crombie, Charles H., West-gate, Burford-road, Whalley-range, Manchester.
Crook, W. E. Froome, 64, Thornfield-road, Uxbridge-road, W.
Dalam, Hon. Dato Bintara, S.P.M.J. (Ibrahim bin Abdullah), Johore Bahru, Johore.
Dattari, Giovanni, Sharia Kasr el Nil, Cairo, Egypt.
De la Plaza, Dr. Victorino, 13, Park-place, St. James, S.W.
Deneke, Moritz, 12, Tokenhouse-yard, E.C.
Denny, John T., 42, Devonport-road, W.
Dewsnup, Ernest Ritson, M.A., Technical College, Huddersfield.
Drummond, James Ramsay, B.A., F.L.S., Gurdaspur, Punjab, India, and care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.
Duncan, Robert, Maarama-crescent, Wellington, New Zealand.
Dutt, B. A., B.A., Katmandu, Nepal, India.
Eastlake, Charles L., J.P., Long Sutton-house, near Langport.
Emtage, Raymond Howard, 14, James-street, Bridgetown, Barbadoes, British West Indies.
Fakhruddin, H. H. M., Halsey-road, Cawnpore, India.
Flanagan, Henry George, Prospect Farm, Komgha, Cape Colony, South Africa.
Foot, Lionel Rayne, Coleman-house, Cape Coast Castle, Gold Coast, West Africa.
Forster, John Walter, 18, Mountfield-gardens, Tunbridge Wells, Kent.
Fosbery, Widenham Francis Widenham, 2, Bute-road, Wallington, Surrey.
Fox, Frederick J., 49, Farquhar-road, Upper Norwood, S.E.
Fraser, James, 12, William-street, Forebank, Dundee.
Gardner, Ernest, M.P., Spencer Farm, Maidenhead, Berks.
Ghose, Dr. Ashutosh, L.M.S., 89, Beadon-street, Calcutta, India.
Gibb, James, Khas Jharia Colliery, Jharia P.O. Bengal, India.
Godwin, J., Assistant Engineer, P.W. Dept., Jammu and Kashmir State, Punjab, India.
Green, Henry Edward Owen, J.P., Bulawayo, Rhodesia, South Africa.
Hall, William Brasier, Engineer-in-Chief's Department, Admiralty, Whitehall, S.W.
Halton-Stone, H., Fostals, Margate road, Herne Bay.

Harris, Wilfred M., Endcliff, Kendal.
Hay, Major Arthur E., United Service Club, Pall Mall, S.W.
Heinze, F. Aug., The Montana Ore Purchasing Co., Butte, Montana, U.S.A.
Herreshoff, Nathaniel Greene, Bristol, Rhode Island, U.S.A.
Hodge, Francis, Coromandel, near Auckland, New Zealand.
Hook, Major David Blair, Herschel, Cape Colony, South Africa.
Horn, Alexander, Messrs. Clarke, Nickolls and Coombs, Limited, Hackney-wick, N.E.
Hornby-Porter, Charles, Lagos, West Africa.
Houghton, Thomas Marcus, 15 Montholme-road, Wandsworth-common, S.W.
Husain, Shaikh Mohammed, Khan Bahadur, H.B.M. Vice-Consul, Jeddah, Arabia.
Johnson, Professor John Butler, University of Wisconsin, Madison, Wisconsin, U.S.A.
Johnston, John Williamson, 46, Leadenhall-st., E.C.
Jones, Frederick John, Treeton-grange, Rotherham.
Just, John Augustus, 116, W. Castle, Syracuse, New York, U.S.A.
Kay, Arthur, Winton Drive, Glasgow.
Keen, Arthur, Sandyford, Edgbaston.
Kelf, Henry Charles, care of Messrs. Parry and Co., Nellikuppam, South Arcot, India.
Khunnah, Juggernauth, Messrs. J. Khunnah and Son, Calcutta, India.
Kidstone, George J., Finlaystone, Langbank, Renfrewshire, N.B.
King, Arthur William Waterlow, Orchard-house, 2 and 4, Great Smith-street, S.W.
Kirby, Frank E., Detroit Shipbuilding Co., Detroit, Michigan, U.S.A.
Knox, G. Walter, B.Sc., 16, Finsbury-circus, E.C.
Kwong Yung Kwang, The Chinese Engineering Mining Co., Linsi Colliery, Tientsin, North China.
Lawes, Sir Charles Bennet, Bart., The Studio, Chelsea-gardens, S.W.
Leonard, Arthur G., Divisional Commissioner for Southern Nigeria, W. Africa.
Lewes, Charles Llewellyn, 12, Old-square, Lincoln's-inn, W.C.
Lewis, E. J., Frant Field, Eden-bridge, Kent.
Little, Edwin, Fleet Engineer, R.N., H.M.S. *Empress of India*, Mediterranean Squadron.
Little, Ernest John, Brentwood-road, Romford.
Löfgren, Alberto, F.L.S., Director do Horto Botanico, Sao Paulo, Brazil, South America.
McDonald, Alex., 171, King's-road, Chelsea, S.W.
MacDonald, S. Fremont, The Ashtabula Hide and Leather Co., Ashtabula, Ohio, U.S.A.
Mackenzie, Thomas B., 342, Duke-street, Glasgow.
Mallik, Ramani Mohan, Meherpore, Nuddea, Bengal, India.
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The CHAIRMAN delivered the following

ADDRESS.

This is the opening meeting of the one hundred and forty-eighth Session of this Society, which was founded in 1754, and incorporated by Royal Charter in 1847. It was established for the Encouragement of the Arts, Manufactures, and Commerce of the country. This was to be effected by bestowing rewards for such productions, inventions, and improvements as tend to the employment of the poor, to the increase of the trade, of the riches, and of the honour of the Empire. Regard was to be paid to meritorious work in the various departments of Fine Arts; to discoveries, inventions, and improvements in Agriculture, Chemistry, Mechanics, and Manufactures.

It is but fitting that the address of the chairman of the first Council elected in the 20th century should survey the doings of the past century in applying the discoveries of science to further the objects of the Society, and to peer into the future to see how far we are likely to continue to do our duty. The workers in the realm of scientific research are increasing in compound ratio. Their weapons of attack upon Nature's secret storehouses are increasing at the same rate. The practical developments of these unknown principles must necessarily grow in ever-widening circular waves of practical utility and increased human comfort. It is dangerous to prophecy, it is simple to forecast. It is impossible to surmise the discoveries that are to come. We only know that they will be absolutely unexpected. But we can observe the progress of existing practical applications of science, and by watching the trend of advancement, and following the motive causes of progress, guess at what is likely to be the result in the immediate future.

The greatest scientific discovery of the 17th century was the law of universal gravitation by Isaac Newton, the absolute truth of which is shown by the accuracy of the time of arrival of every eclipse and of every occultation, and in the construction of that wonderful production, "The Nautical Almanac."

The greatest scientific discovery of the 18th century, was the "law of Watt," which determined the latent heat of steam condensation at different temperatures and pressures, and enabled that great engineer, during the five years from 1761 to 1768, to work out "all the principles and invent all that was essential in the details for realising them in the most perfect steam engines of the present day"—(Kelvin).

The great scientific discoveries of the 19th century have been :—

1. The principle of evolution.
2. The atomic structure of matter.
3. The existence of the æther and the undulatory theory of light.
4. The principles of electro-magnetic induction and electrolysis.
5. The principle of the conservation of energy.

I enumerate these discoveries, not in their historical order, but in the order in which I purpose to discuss them.

1. The Principle of Evolution.

Huxley regarded the emergence of the philosophy of evolution under the guidance of Darwin as the most portentous event of the 19th century. It constituted an epoch in the intellectual world, and originated a new weapon of research in the material world. Applied to organic beings, it shows that species have descended each in its own class from common parents, and have been modified and improved in the course of descent and in time by natural selection. Natural selection is the survival of the fittest in the struggle for existence in the organic world. It is variation of type arising from necessary adaptation to surrounding conditions. It is the motive cause of evolution in Nature. The European horse was thus slowly evolved from some antediluvian quagga.

Man, with his power of observation, experiment, and thought has materially hastened this process by intelligent selection. The heavy horse of the Roman cavalry has become the sleek and swift Volodyovski—the winner of the first Derby of the 20th century. A type of racer which, at the commencement of the 19th century would have been sold for perhaps £1,000, fetched last month as a two-year-old the enormous price of £21,000. The American trotter which in 1844 was supposed to do a wonder when it trotted one mile in 2 mins. 28 secs., is now able to do the same distance in 2 mins. 5 secs. Man works not only by the selection of the fittest but by the removal of the weakest. The useless is relegated to the four-wheeler or the knacker's yard.

This selective modification by human intelligence is strikingly shown by the rapid development of the modern practical applications of science to the wants of man. James Watt, who took 12 days to travel on horseback from Glasgow to London in 1755, could now by the evolution of his own invention into the last iron horse of Crewe, "Victorious," do the distance in 7½ hours. The lumbering stage coach that could carry only 20 persons in 3 days has developed into the corridor train carrying 420 sumptuously fed, luxuriously seated, and well warmed passengers, doing the same distance in eight hours.

The search for food is the prevailing motive force in the struggle for existence in the organic world. The struggle for power among the nations, the race for wealth among individuals, the love of travel, the pursuit of knowledge, the removal of disease, and the comfort of living, are the mainsprings of that selective modification that characterises the rapid progress of civilisation upon the surface of the earth. What is it leading to? What is going to occur in the coming century? The English racehorse, the American trotter have been evolved by the selection and breeding of fleeter and fleeter individuals, and the brewer's drayhorse by a similar selection and breeding of heavier and heavier individuals. The dining-car of to-day has been evolved by the desire to remove every cause of delay in transit, and to add every comfort and luxury to relieve the human body from the fatigues of travelling. We have not come to finality. Improvements and inventions are annually appearing. It is by carefully observing the direction of improvement, and determining the motive causes, that makes it not difficult to forecast the probable developments of existing applications in the coming century.

2. The Atomic Structure of Matter.

Matter is that which is perceptible to the senses. It can be weighed. The quantity of matter in the universe is fixed—it can be neither added to nor destroyed by man. Matter is reducible to about seventy different elements, and it is found in three states—solid, liquid, and gaseous. We can transform matter from one state to another by imparting or withdrawing energy to or from it in the form of heat. If all the heat it possesses be withdrawn, matter attains the absolute zero of temperature. Professor Dewar has been making persistent and indomitable attacks upon this stronghold, and has approached it within 15° C.; that is, he has attained a negative temperature of —258° C. At —273° C. (absolute zero) matter must be inert, but it must retain its force of cohesion. In what state will matter be found? The 20th century will know.

The end of the 19th century has been characterised by the discovery of several new elements—argon, helium, krypton, neon, and xenon. There are probably more lying *perdu* waiting to be discovered.

The atomic character of matter was published by Dalton in 1807. It has been so developed in the 19th century that it has become a fundamental article of faith among scientific men. The atom is the smallest indivisible portion of matter. It is a manufactured article, the brick with which material structures are erected. Atoms are grouped together by affinities and forces into molecules, and molecules mixed and bound together become matter as we know it. The size of the atom has even been approximately measured, though its minuteness is practically beyond human mental grasp. Lord Kelvin suggested that if we conceived a drop of water magnified to the size of the earth, the atom would be something between a shot and an orange. Recent researches by Prof. J. J. Thomson, in Cambridge, lead to the conclusion that Lord Kelvin's lowest limit is nearer the mark. Atoms grouped together in various numbers are called *molecules*. The chemist not only transforms matter from one state to the other, by manipulating energy, but by linking, delinking, and relinking atoms and molecules, and by manipulating their internal forces, he transforms it into innumerable new combinations for the use, benefit, and destruction of man.

The essence of the atomic theory is that matter is coarse-grained. It consists of concrete particles subject to independent motions. It is not a continuous medium. We know this by the diffusion of gold into lead, and *vice versa*, as determined by Sir William Roberts-Austen, and by the changes of form that follow changes of temperature—the great enemy of the engineer, against whom he must be always on the defence.

The trend of research at the commencement of the 20th century, is to prove that the basis of all matter is fundamentally the same, and that the true atom has not yet been reached. We have some knowledge of the "atoms" of each element, but Sir Norman Lockyer suggests that there are "bricks" in every atom which are all alike, and that we have not yet reached the true fundamental article created in the beginning. Matter, as we know it, has been evolved from this unrevealed base. This problem will be solved in the coming century.

3. THE EXISTENCE OF THE ÆTHER AND THE UNDULATORY THEORY OF LIGHT.

The æther is that imponderable continuous medium that fills all space, inconceivable in its immensity, inexplicable in its mechanical structure, but as real in its existence as the hall in which we meet, and the air that enables you to hear my words. The 19th century was characterised by many hypotheses to explain this mystery, and the 20th century commences without the existence of an acceptable theory. Our grand old man of science, Lord Kelvin, has tackled the problem with all the energy of his vigorous mind, but while he has established the presence of the æther, he has failed to invent the final theory of its structure. The æther offers no resistance to wave motion through it. Every little star that twinkles proclaims the presence of the æther, and the freedom of its wave action. Energy is not dissipated away in it into heat, as in the undulations and vibration of matter. Energy waves of all kinds move with the same speed, viz., 300,000,000 metres per second, or say, 186,400 miles per second.

It was Young, in 1801, who established the undulatory theory of light, attributing it to the waves of an æther, and this with the assistance of Fresnel, dispelled Newton's emissive corpuscular hypothesis. The great authority of Newton enslaved the scientific world for nearly 200 years with the notion that light was a form of matter, and I remember well Balfour Stewart in 1866 giving a Friday evening lecture on the relative merits of the two theories. Newton may have adherents even now! We have great cranks in science. Scientific men are very conservative even though their *raison d'etre* is so progressive and radical. The undulatory theory of light like the atomic structure of matter is, however, now a subject of implicit faith.

The undulatory theory of light not only accounts for the colours of the rainbow, but it tells us of the stuff of which the sun and stars are composed. Bunsen and Kirchkoff gave us the spectroscope which did this, but which in the hands of Sir William Huggins also told us the rate at which stars are approaching or receding from us. The spectroscope was one of the precious scientific gifts of the 19th century, and in the 20th century it is going to enable the engineer to analyse, purify, and perfect the materials he uses to carry out his practical functions. It has already announced the presence of new elements, which the chemist, by his patience and skill, has extracted from the earth. Helium was seen in the sun's spectrum; it has now been found in our earth.

4. THE PRINCIPLES OF ELECTRO-MAGNETIC INDUCTION AND ELECTROLYSIS.

I have always regarded Faraday's "Researches" as the Bible of the electrician, but in the express rate of living of the present day, and the phenomenal development of the applications of electricity, few of our practical engineers have time to study this magnificent work. Faraday established the identity of electricity and magnetism; he invented the conception of magnetic lines of force, and the existence of the magnetic field; he showed how the motion of these lines of force across conductors, or the motion of conductors across the lines of force, produced definite and measureable electromotive forces. He showed how these lines of force moved through matter and through space, and he led Maxwell to establish the identity of electricity and light, and the fact that electromagnetic waves through the æther were the same as light waves. He found that varying currents produced currents by induction in neighbouring conductors at a distance. Faraday's discoveries lie at the root of every dynamo and every motor, and they form the basis of every practical application of electricity. He said: "I have rather been desirous of discovering new facts and relations dependent on magnetic-electric induction, than of exalting the force of all those already obtained, being assured that the latter would find their full development hereafter." He was not a practical man, but he was a prophet. He was essentially a philosopher, a discoverer, and a teacher. There is no monument to Faraday, except a statue in the Hall of the Royal Institution. His bust should be in every generating station. No one has done more to unravel the mysteries of electricity, and those who were brought in contact with him, as I was, reverence his memory. His greatest discovery was that of electromagnetic induction, but the observation of two waves of electricity in a long under-ground circuit was equally pregnant, for it anticipated Maxwell's mathematics and Hertz's great experiment.

Equally important were his researches upon the action of electrical currents in breaking up electrolytes into their constituent elements. Faraday's law on this subject—as accurate as Newton's law of gravity, and of his own electromagnetic law—is the basis of the great electroplating industry, of the production of pure metals from their ores, and of all electrochemical industries.

5. THE PRINCIPLE OF THE CONSERVATION OF ENERGY.

Energy is the capacity to do work. Work implies the motion of matter against resistance. The earth rotates round the sun, the moon round the earth, the tides ebb and flow, rivers run on for ever, locomotives pull trams, horses draw carriages, electric currents lift weights, in virtue of the energy impressed upon them. Matter would remain absolutely inert if it had not energy. It is active only because it possesses energy.

The conservation of energy implies that it is a fixed quantity in the universe. It can be neither added to nor destroyed by man. It can only be transformed from one kind of motion to another—material or ætherial. The motions of matter can be converted into the motions of the æther, or *vice versâ*. Whenever work is done on the earth it is at the expense of energy withdrawn from somewhere else. The sun is the centre and spring of all energy on this earth. Sound, light, heat, electricity, and magnetism are mere forms of energy. The principal function of the engineer has been to apply these forms to secure the comfort, well-being, happiness, and health of man. By adhering to the principle of energy, and by measuring every transformation, the engineer is able to separate the wheat from the chaff, to sift that which is waste from that which is useful, to render the efficiency of his machines a maximum, and to reduce the absolute waste or dissipation of energy to a minimum.

Although the principle of energy is the last that I have taken of the great discoveries of the 19th century, it unquestionably is the greatest in its far reaching and economical qualities. Faraday had grasped the idea of the conservation of energy long before the principle was published, but the principal labourers who have established this great doctrine, are Joule, Helmholtz, Clausius, Rankin, Maxwell, and Lord Kelvin, who is still working in this field.

The criterion of true advance in knowledge is the possession of standards and of means of accurate measurement. We commence the 20th century remarkably well equipped with both these requisites. The engineer has only to take care of his "Joules," or units of energy, and his machines will take care of themselves.

THE PRACTICAL APPLICATIONS OF ENERGY.

I will now consider the applications of energy to the Arts, Manufactures, and Commerce of this country, under its different forms of *heat*, *light*, *electricity*, *magnetism*, *sound*, and in its general usually termed quality, *power*.

1. *Heat.*—The employment of that form of energy called heat, which is obtained when oxygen combines with carbon in a furnace under a boiler to generate steam, has led to the development of the mechanical resources of the civilised world to an extent that is almost beyond the comprehension of the mind. Watt commenced his engineering career practically with the 19th century, but Trevithick, Woolf, Stephenson, Regnault, Hirn, Penn, Corliss, Willans and many others have marched onward triumphantly from victory to victory, until we are producing engines to-day that are ten times more effective than those made in Soho in 1800. Modern progress is due to the use of the principle taught by Sir Frederick Bramwell; that we must make and carefully study a balance-sheet of all the debits and credits of energy obtained, used, lost inevitably, lost wastefully, and lost foolishly. Science has taught us how to measure accurately, and Practice has produced apparatus that effectively and simply does what is needed. The publication of papers and the discussion of results have excited an intense international as well as a patriotic feeling of emulation that has been most beneficial to this progress. The consumption of coal per indicated horse-power per hour which, at the commencement of the 19th century, generally exceeded 10 lbs., has now fallen to 1 lb. The working of steam expansively, which, curiously enough, was abandoned by Watt, its inventor, is now utilized four times over. Pressures, which were then only 15 lbs. per square inch, have reached 200 lbs. The amount of heat converted into work is scarcely 15 per cent. of that of the contained energy. All the rest is virtually wasted. The prevention of condensation in the steam-pipes and in the cylinders, quicker action of the steam valves, proper control of air admission, regulation of heating area, tubular boilers, superheaters, fuel-water heaters, economisers *et id genus omne* have reduced the waste of fuel, the waste of water, the waste of steam, the waste of heat up the flues and in the boiler and engine room, to a good practical minimum, though not to the true theoretic minimum, so that there still remains a field for the mechanical engineer to apply his science to the betterment of his practice, and to the further improvement of the steam engine.

The 19th century gave us other fuels. Oil is replacing coal in the furnace, but oil, in its gaseous state, and coal gas mixed with air and exploded, have displaced the furnace and boiler and given us engines of still higher efficiencies, but of smaller dimensions. Lenoir, Otto, and Diesen, inaugurated an industry that is certain to make great progress in the coming era. At present, while a steam engine developes 30,000 indicated horse-power, and even more, gas engines are in the hundreds and oil engines in the tens. Mr. Westinghouse, one of the most energetic of his irrepressible race, is devoting his attention to this enlargement of the gas engine to 1,500 indicated horse-power, and we can only wish him every success. Mr. Ludwig Mond has been very successful in producing a cheap gas for power purposes, and all the mechanical world is watching the development of his great power scheme in the South Staffordshire district.

The utilization of heat in metallurgical processes, in various chemical industries, and in all manufactures, has passed through the same beneficial evolution. Practice which commenced with the free use of the rule of thumb, has been forced by imitation and competition to observe and experiment and to bring science to its aid. Foreign competition has done what preaching never could have done. The loss of profits has proved a motive force which has made the conservative British manufacturer wince, think, and reform. We were pioneers too long. We are not now in the front rank, but we are far enough from the goal to enable us with careful jockeying to regain our lead. Our motto always has been and ever will be *nil desperandum*.

2. *Light.*—Great Britain, however, has still the mastery of the seas, and she is the great maritime carrier of the world. Her ships have to cross the main by night and by day. Sailors rather like to navigate by night, for lights aid their operations. They do not make themselves "snug for the night," like their Elizabethan predecessors. Fog is their principal enemy, as it is ours in this metropolis, where the palpable obscurity of a carbon-bearing cloud fills our streets, rooms, throats, nostrils and eyes. Our physical friends ought to commence the century with the firm determination to attack this enemy and to let our grandchildren smile at the memory of the misery of their fog-folded grandfathers. Principal Oliver Lodge cleared a glass globe full of fog by an electric discharge. Let him act on "the great globe itself," commencing in Birmingham. I venture to suggest that the first operation to ameliorate the evil in London is to enforce the Act compelling people to consume their own smoke, and save us from consuming that of others.

The evolution of the lighthouse and lightship from the beacon of the first Eddystone of Winstanley to the "Feu éclair" that was so prominent last year in Paris, and is so brilliant off Ushant, Cap Gris Nez, and many French headlands, is an interesting history. The lighting of our seaways is, around England, in the hands of the Trinity House, around Scotland in the Commissioners of Northern Lights, and around Ireland in the Commissioners of Irish Lights. Airy, Kelvin, Faraday, Tyndal, Chance, Hopkinson, Stevenson, and Douglass are names associated with its early progress in England. The new Eddystone, the Smalls, the Wolf, the Longships, the Fastnet, Skerryvore, are brilliant examples of engineering work. Smeaton taught us how to copy nature in building a tower, and his example has been but little departed from. Iron has recently been introduced, but the charm of perpetuity seems to be attached to the time-honoured granite. The illuminants have passed since the first Pharos was erected at Alexandria 2,000 years ago through wood and coal fires, tallow and wax candles, vegetable and organic oils until the present day, when we find heavy mineral oil, gas, and electricity on their trial.

The lenticular lanterns follow the invention of Fresnel, while the lamps are as numerous as the engineers who use them. The four-wick oil lamp of Fresnel gave 230 candle-power, while the six-wick lamp of Douglass gives 800 candles. Wigham's gas lamp gives 2,750 candles, and the light of the electric arc is reckoned in millions. Brilliant as the last is in clear weather, it does not seem to be more effective than oil in thick weather. Hence of the 1,100 lights we have in Great Britain only five are fitted electrically.

Of the 80 lightships all are fitted with two-wick oil burners, but they flash lights that are estimated as equivalent to 20,000 candles. Flashing are found far superior to fixed lights, for they are not mistaken for ships' lights—a fruitful source of error and disaster. Hence group-flashing is the order of the day.

Owing to the prevalence of that arch enemy fog about our channels, light must be supplemented by sound signals. Hence we find bells, guns, gongs, trumpets, rockets, guncotton bombs, screamers, whistles, and sirens. Tyndall showed that fog does not impair sound —in fact it tends rather to intensify it; and experience shows that the most characteristic, distinctive, and penetrating sound signal is the siren. This is therefore becoming general, operated by steam or compressed air.

The "feux éclairs" designed by Bourdelles, and favoured so much by France, is the coming light. Annular lenses are rotated with considerable velocity with very short intervals between the brilliant flashes, and they wave across the firmament arms of light that seem to warn away the mariner from some point of danger.

The coming century with its growth of industry, its increased speed of transit through the sea, the expansion of the number of ports, and the size and value of ships will see the importance of our channel lighting augmenting in the same proportion. The apparent anomaly of having three Boards, where one would do, the better classification of our lights, a more uniform employment of sound signals must enforce consideration. The position we hold is quite becoming to the nation. We have no fault to find with those who have maintained, and in virtue of their intelligent solution are improving, this inestimable and invaluable service.

Photography.—Photography, in its inception and development, was the child of the 19th century. It was begotten in the early years of the century, born about the middle of it, and reached its full powers shortly before its close. Few applications of science have been more useful, none more popular. Its progress, too, is of special interest to us, as its development was to a very large extent the work of Englishmen. Photography was certainly born in France. The first man who ever made a picture by the agency of light was Nicéphore Niepce. The first man who introduced a practical photographic process was Daguerre. But though the art originated in France, it was developed in England. Fox-Talbot, with his paper negatives, first produced a method by which numerous copies can be made from a single original, and Archer, by employing a transparent film of collodion as the vehicle for the sensitive salt of silver, completed the work of his predecessors, at once made the practice of photography easy, and its results perfect. For many years the wet collodion process had no rival, though many workers were occupied in the endeavour to discover some means by which a sensitive surface could be prepared which did not require immediate development, but could be carried to the spot where the photograph had to be taken, and afterwards developed at home. The substitution of gelatine for collodion as the material in which the sensitive material was imprisoned, produced the modern dry plate, and laid the foundation of what is now a very large and important industry, an industry of which the principal seat may still be said to be in England, though France, America, and other countries are very important rivals.

It is due to the gelatine dry plate that photography has taken the important position it now holds as an aid in almost every branch of scientific research. It enables an accurate record to be easily obtained of any observation, while the speed with which light impressions are received, enables observations to be made which the human eye is absolutely incapable of following. By its aid the movements of animals have been analysed; the flight of a bullet has been traced with the accompanying series of air waves to which it gives rise; the formations and movements of a falling drop of water can be accurately analysed at any instant of its progress; in fact, the various stages of a phenomenon occupying a small portion of a second, can be traced and set out for examination at leisure. On the other hand, the fact that a photographic plate can accumulate the result of light impulse upon it, enables it to observe and record what has never and can never be seen by human vision. A photograph of the heavens shows uncounted millions of stars which the eye has never seen, and never will see. The use of the spectroscope is entirely dependent on photography, which, in this, as in many other cases, has entirely superseded eye observations, and as much may almost be said of the astronomical telescope. In the observation of eclipses, which last but a few minutes of time, observations can be recorded which require two or three years for their working out. It is hardly possible to mention any branch of scientific research—physical, chemical, astronomical, meteorological, physiological, microscopical, or medical—in which photography does not play an important part. It would indeed be difficult to over-rate the assistance that photography has rendered to science, and it may safely be said, that without that assistance the progress of scientific research would have been far slower than it has been, and it certainly could not have reached the point it has at present attained.

3. *Electricity.*—Electricity is another form of energy due either to the permanent rotation of the atoms about an axis giving a polarized effect, or to the existence of a distinct electrical atom of some imaginary quasi-matter, *sui generis*, to which the name of the *electron* has been given, possessing similar rotatory properties of opposite sense. The latter view is running very strong at the commencement of the present century, especially among the Cambridge school of scientists, but the former is held by the engineering world, who have been the leaders in the marvellous development of this branch of industry. The 20th century will soon settle the question.

The Electric Telegraph is the child of the 19th century. The first practical circuit of five wires was erected by Cooke and Wheatstone, between Euston and Camden, on July 25th, 1837. It was developed by private enterprise. It became a gigantic and imperial business, unequally distributed among the people, the shuttlecock of rival companies, costly both to press and to public—a business that so intimately affected the whole community, that in 1868-9 Parliament stept in, bought it on very fair terms, and placed its control in the hands of the Post Office. The Post Office has kept its charter well. A message to Glasgow cost at first 8⅖d. per word; we can now telegraph everywhere in the United Kingdom for ½d. per word. The average price of a *whole message* is now 7·4d.; it was at the transfer to the State 2s. 1⅘d.; there were then 2,932 offices open, there are now 11,512; the revenue was £612,301, it is now £3,459,353; the number of messages was 6,000,000 for the year 1869, it was last year 89,576,961; the number of instruments fixed was it is now 35,708. In 1837 it required five wires to transmit ten words per minute, now one wire can transmit 600 words per minute; six distinct messages can now be sent on the same wire at the same time; the mileage of wire was 50,000 miles, it is now 275,000. The public has no reason to despair of its property. It cost them £5,000,000. What would an American syndicate give for such a business—a revenue of 3½ millions, no capital, and a magnificent plant that has been built out of profits? It is worth £30,000,000. There are 187,353 nautical miles of cable submerged in the seas, 167,300 of which belong to private companies.

About 80,000 miles of wire and 20,000 instruments are employed on our railways. Every railway company has its own system, which it uses for its own purposes, to conduct its business and its traffic, and to secure the safety of its passengers. The monopoly of the Postmaster-General applies only to message-carrying for profit.

The printing telegraph of Hughes is used on all Continental international circuits, and it teaches us how simple and comforting telegraphy would be if we could have all our telegrams printed in type. This is coming. It is even on trial now at our Post-office, and more than this we shall be able to have our own handwriting reproduced at a distance and our own unmistakeable signature delivered. There is no apparent cessation to the progress of telegraphy.

Wireless Telegraphy.—An immense sensation has been created in these later days by the facility we have acquired of transmitting messages across space to ships in motion at great distances. Gibbon, in his "Decline and Fall of the Roman Empire," mentions that in the Capitol "the statues of all the provinces were arranged in order, each with a small bell suspended from the neck, and such was the contrivance of art magic that if the province rebelled against Rome, the statue turned round to that quarter of the Heavens, the bell rang, the Prophet of the Capitol reported the prodigy and the Senate was admonished of the impending danger."

The completion of an electric circuit through water was effected by Morse in America in 1844, and by Lindsay in Dundee in 1854; and it has been in regular practical use in India for bridging rivers for many years. In 1884 the distance to which electrical disturbances upon telephones were transmitted through space attracted my attention, and I reported the result to the Bristol Association at the Canadian meeting at Montreal. In 1893, at Chicago, I was able to announce the transmission of messages across 3·3 miles to Flat Holm in the Bristol Channel. In 1894 I reported to the Society of Arts that speech had been transmitted *by telephone* across Loch Ness, 1¼ miles in the highlands. My paper ended thus, "If any of the planets be populated (say Mars) with beings like ourselves, having the gift of language and the knowledge to adopt the great forces of nature to their wants, then if they could oscillate immense stores of electrical energy to and fro in electrical order, it would be possible for us to hold commune by telephone with the people of Mars."

In April, 1895, communication was maintained by my system with the island of Mull during the breakdown of the cable. In 1896 Mr. Marconi came to England, and the resources of the Post Office were placed at his disposal for experiment and trial. They were successful. The conclusion I came to was that while his system was practical, the field for its use was limited. It was eminently adapted for communication between ship and ship and between ship and shore. For the navy it would be of great service, and for lightship service it might be beneficial, but that it was going to dispense with submarine cables or with poles and wires was quite chimerical. It is still quite in an experimental stage, but it has attracted an immense amount of attention in connection with the highly successful imperial tour of their Royal Highnesses, our Prince and Princess of Wales.

It is impossible to predicate what will happen in the 20th century. Progress is slow; anticipations are wild. Mr. Marconi personally is to be very sincerely congratulated on what he has already done, and everyone wishes him continued success.

The Telephone.—Far and away above all other electrical developments in wonder and simplicity has been the telephone, developed by Graham Bell in 1876, and perfected by Edison and Hughes in 1878. That articulate speech can be conveyed and reproduced at the Land's End through a thin wire from John o' Groats; that we can speak with perfect ease between London and Paris; that from my home in the Welsh hills, I can talk to my office in London; that I can send by mouth and receive by ear all my telegrams without delay to and from my post office in Carnarvon, and that it would be possible for every person in every house in England to chat, cry and laugh with one another at any time, transends all poetic imagery, all dreams of magic, and the wildest conceptions of the most sanguine inventor. Twenty-four years have passed since I brought the first pair of telephones to Europe. It would have been everywhere, but for mismanagement. The representatives of the property demanded such exorbitant terms for the purchase of the patents, that much time was lost in inaugurating the business, and much prejudice excited. Litigation ensued with the Post Office, and the law decreed that the telephone as a message-earning machine by electricity, was included in the Post-master-General's monopoly. The Government never firmly faced the situation. Unlimited licenses were issued. Companies sprang up like mushrooms. They were, by the usual financial means, consolidated into one big company. The Post Office opened a few small exchanges. It was not allowed to compete. A monopoly in the hands of private enterprise and without statutory rights, is never popular. Dissatisfaction existed everywhere. Parliament interfered; a committee of enquiry was held in 1896 and the result was inconclusive and unfortunate. Confusion became worse confounded. The real and only solution has not yet been taken. A cheap, efficient, and reliable telephone service is imperial, and like the letters, parcels and telegraphs, should be solely in the hands of the Government. In spite of these troubles, the development of the business has been remarkable. The mechanical and electrical development has been equally progressive. The instrument itself retains its original simplicity, but the switches and accessories at the exchange or central station have become more complicated, but more adapted to prompt and effective service. All calls and signals are automatic in their action. No time is lost, and the only troubles are external ones and the prior occupation of the circuits. Busy houses find it necessary to multiply their circuits, but long trunk lines are not so simply multiplied as short local exchange connections. Everybody who uses an exchange should visit it to appreciate the work done in his service, and he should regard himself as a part of the machine. The 20th century will see a great development and consolidation of the business, but the simple and effective apparatus leaves little room for improvement. We already see changes for the sake of change creeping in for commercial and financial reasons, but not for improved working's sake.

The Electric Light.—The development of the electric light since Edison and Swan brought out the glow lamp in 1881, has been phenomenal. It has been taken up with great avidity in the United Kingdom, and its use is increasing with leaps and bounds.

The use of arc lamps for street illumination in the United Kingdom, is not to be compared with the practice in the United States, but the difference is due to the universal presence of cheap gas here, and of no or dear gas in the States. As a matter of fact, gas improved by the Auer mantle can compete satisfactorily with electricity in this direction. It is in domestic life where the electric light has made such strides in the United Kingdom. It is in living rooms where electricity is paramount. Here the light is pure, the air we breathe is not vitiated, health is not affected, comfort is assured, and cheapness is secured. Lamps are being improved every day. The tendency is to make them more efficient and therefore cheaper to work, for they consume less current. The cheapness of supply is also developing by the increased use of electric energy for traction, motive, and heating purposes. The larger the plant in the generating station, and the greater the continuous number of hours the load is on, the cheaper is the cost of generation. The potentiality of cheapness in our large municipalites is beyond the dreams of the economist. In Bradford it is now only 1·22d. per Board of Trade unit, and this is equivalent to gas at 7·32d. per 1,000 ft. It is possible to contemplate the generation of electrical energy at ¼d. per unit.

Heating by Electricity.—An electric current being one form of energy, does work upon a conductor which maintains it, shaking up its molecules into the other form of energy called *heat*. The amount of heat excited and radiated forth is easily measured by the law of Joule. This is the principle of the glow lamp, where the heat being confined to a fine carbon filament, raises the temperature of that filament so high that light is emitted. The brilliancy of the light depends upon the temperature, and it is limited only by the refractory character of the filament. The highest temperature is attained in the arc.

Hence we obtain heat for useful purposes, either by disruptive discharge in the arc, or by metallic resistance in coils. The former is used principally for industrial purposes, and especially in the electro-chemical processes. Phosphorus, aluminium, calcium carbide, and several other materials are produced by it. It is used also for welding, especially gas pipes and fittings. The latter is used domestically for warming rooms, beds, water, and even cooking. Radiators for cold rooms and shops are excellent things, but at present a little costly to maintain; hygienically, they are unexceptional. I have contemplated using a coil inside a Tobin tube to heat the fresh air as it enters my bedroom, but I am deterred by the cost of the current at present. This cost will diminish, as I have already pointed out, and then we shall waste much less coal than we do at present. There are many people who imagine that electrical energy is dear in England because of the absence of water-power. We have no waterfalls in England to utilise, but in Switzerland, where there is plenty of water, it is utilised to a large extent. I am, however, assured by Mr. Dawson, a very competent authority, that energy in Switzerland is not produced so cheaply as we can produce it on our coalfields. It is a fallacy to imagine that you can dam up a valley, make a waterfall, and use it for the cheap production of electrical energy. The capital spent in hydraulic works demands an interest that exceeds, in every case I have enquired into, the cost of the coal to produce the same energy. Even the waters of Niagara cannot compete with oil and coal in Buffalo eighteen miles off. It has been pointed out time after time that we do not sufficiently utilise our coal-fields. Power Bills have passed Parliament, but only one is at work; one other is in progress on a very small scale, and the rest lie dormant. It is the fashion to attribute our backwardness to ignorance, to the absence of education, to conservatism, to prejudice, to the lack of enterprise. The cry is for adequate endowment and encouragement of research; but no one has pointed out the true Homocea which touches the spot. It is the timid financier who is the cause of all our trouble; it is he who has been frightened by the financial failures of the past, and whose confidence in electrical ventures has been shattered by the terrible infliction of the Limited Liability Act, and its offspring, the company promoter. The panic, the result of the excitement of 1881-2, has not yet been blown away.

Motive Power.—Cheap electrical energy means economy wherever power is wanted. We have learnt that energy is something to be used, not wasted. Few know the waste of power in steam pipes, in shafting, belting, and ordinary mechanical appliances for the transmission of power. It is not too much to say that every colliery, and slate and stone quarry, uses twice as much coal as it ought to. All our principal manufacturers are finding out the waste in their shops, and the rapidity with which electric motors are being introduced, is astonishing. For some peculiar reason the British manufacturer is very secretive. He does not want his competitor to know what he is doing. But those of us who have opportunities of knowing the facts, can smile at the pessimistic strictures of the ignorant, and feel like the great Roman, no despair of our own country. There is no such educator as a loss of profits, and no such motive cause for economy as experiencing successful competition. The principles of Free Trade have encouraged competition, and we must cheerfully meet and fight the Frankenstein monster we have made, with our eyes very wide open.

Legislation.—A distinguishing feature of legislation during the latter part of the 19th century has been the encouragement of municipal trading. One beneficial effect of this action of Parliament has been evidenced by the rabid opposition by the company promoter to all operations under these powers. The introduction of the Limited Liability Act of 1862 has led to the formation of a system of plunder that far exceeds in intensity any crime that was ever invented or practised. The Act of 1882 checked this depredation on the purse of the confiding public in electrical undertakings, but its effect has been much weakened by the tendency of corporations to exceed their legitimate functions. The margin of municipal trading is well defined by confining it to those businesses that effect the whole community. When it treads on the corns of its own ratepayers it is illegitimate. Roads, sewers, tramways, illumination, come within this category, and the exercise of these powers by local authorities has proved beneficial to the communities they govern, for they have been able to establish their business with a less expenditure of capital, and to obtain their benefits for less annual expenditure. The profits have gone, not to make fat dividends, but to ameliorate the rates. The principal argument brought against this system of municipal trading, is that it checks private enterprise. It certainly does this, both when inaugurated by the just and unjust, but fortunately and principally it has checked the unjust, whose machinations in floating public companies are so frequently such edifying reading in the reports of the proceedings of our law courts.

The Act of 1870 certainly checked the construction of tramways, but the Electric Light Act of 1882, stopped gross financial abuse and wild speculation in the early days of electric light development. It was a beneficial Act. It placed the supply of electric energy on a legal, scientific, and solid basis. It has not prevented the operations of legitimate private enterprise. London is a prominent example of this. Our own building is lighted by the London Electric Supply Company and the Charing Cross Company, while Liverpool, Sheffield, Leeds, Birmingham, and now Norwich and Dover, are cities whose corporations have had to pay dearly for failing to grasp the value of the privilege which Parliament gave them, but which Manchester, Glasgow, Bristol, Hammersmith, Hampstead, and very many others appreciated. Difficulties have arisen in the operation of the Acts of 1882-8, not so much from any antagonism between private and municipal enterprise, as from the existence of powerfully vested interests like gas and water companies, and from the weakness of the councils of small places, which are not usually selected from the classes best educated and trained to govern, but from those who are too much controlled by self-interest, and whose foresight and business acumen is much restricted by the small sphere of their own operations. As Tennyson said, "If God made the country and man made the town, the devil made the little country town."

On the whole, the operation of the Acts has been very beneficial to the public. Electric lighting among the poorer classes has developed in a way unknown in any other country. It has become in many places, from its economy, the poor man's light. But above all, it has stirred up the oil and gas interest. Artificial illumination has vastly improved, and the public are now supplied with lamps which, compared with the farthing dip and snuffing operations of my youth, produce as great a contrast as London enveloped in black fog and London bathed in brilliant sunshine. We are advancing well. The trend is towards economy, efficiency, and comfort. The 20th century will see great advances in much-needed street lighting. Gas and electricity will join hands. Cheaper generation of energy, more efficient lamps, and plenty of them, will render our evening's peregrinations as pleasant and as safe as day locomotion. Our homes will be made healthier. The comfort and effectiveness of internal illumination will not be restricted, but all will be able to turn night into day without unnecessary heat or improper vitiation of the air.

The Press.—A remarkable outcome of the introduction of cheap telegraphy by the Post-office has been the development of the provincial, and a marked improvement in the London Press. In no country is there such a complete system of telegraphy for news purposes as in the United Kingdom. No less than twenty-four circuits extend from London to the great centres of population, for the exclusive use of individual newspapers, from 6 p.m. to 6 a.m. every night. Several of them have their own private wires for their sole use night and day. The Press rates are very low. The price is 2d. for 100 words. The Department loses £400,000 per annum by the transaction; but the real sufferer, the public, smiles, while the real beneficiary, the Press, grumbles and growls. The work done for the Press in the last year of the 19th century, was —telegrams delivered, 140,321, and words delivered, 16,838,522 in one week.

The *Times* every morning enlightens us on the evolution of its massive sheets, by giving us entertaining extracts from its issue of the same morning in 1801. I give a sample from the *Times* of November 2, 1801:—

"A letter from a Correspondent at Bath, states, that the company has much encreased during the last week. There is every species of character and caricature—Lords without money—Gentlemen without manners — complexions without health, and beauties without paint. Here are plenty of minor Poets, and though not many *common beggars*, there are many petitioning reduced old gentlemen and ladies, poor widows, &c. There are not many flats, but the sharps are encreasing so fast, that a feather'd pigeon is scarcely worth dividing.

"The Paris Journals continue to teem with the most fulsom flattery of the CHIEF CONSUL, for concluding the Peace. The following are specimens of the epithets applied to him:—'*Eternal glory and gratitude* to the Pacifier of the World.' '*Immortal glory* to the Pacifier of the World.' 'Let thanks be *eternally* rendered to you.'—'Thy name is as much *revered* as formidable among all the nations of the universe.'—'Thou hast given peace to the nations.' —'For thee Fame has fatigued her hundred mouths, and Glory has exhausted her crowns.'

"The horned cattle that were driven out of Smithfield, because they could not fetch their price, were immediately divided between Westminster-Hall and Doctors-Commons, where they are sure of making a good market at all times.

"Our charming *Godivas* of fashion seem to have studied well the panegyric of ARISTENETUS.—*Induitur? formosa est: Exuitur? ipsa forma est.* It cannot be disputed but that they are *Beauty itself*, and that if they were more dressed, they would *only* be beautiful."

We can scarcely conceive the stately *Thunderer* a light daily *Punch*. Times have, indeed, changed. The leading journal is now a marvel of literary style, of press management, of news collection, of accurate reports. We know on our breakfast table the news of the whole world of the previous day. Packets are not belated in the channel, or captured by the enemy on the high seas. The magic wire connects Printing House-square with its own correspondents in every capital of Europe, and the 160,000 miles of submarine cable keeps London in touch with every quarter of the globe.

Extraordinary improvements have been made in printing during the last hundred years. Previous to the year 1800, printing was all done on the old wooden presses, and before the *Times* started their steam machine in that year, all they could get in an hour from a hand-press worked by two men, was 300 copies of two small pages.

Earl Stanhope, in 1800, made the first printing press, composed entirely of iron; Koenig, in 1804, constructed the first practically useful machine. The *Times* in 1814 commenced printing their newspaper by steam power, then the new era began. Ten years later, improvements on this machine enabled the proprietors of the *Times* to double their output of 1,100 copies; and owing to the machine makers' continual endeavours, by the year 1852, printing machines were working at the rate of 11,000 to 12,000 copies per hour.

The 1d. stamp duty and the paper duties checked progress, but the former was abolished in 1855, and the latter in 1861. The penny newspaper flooded the land; the halfpenny evening journal followed, but the great features of the latter part of the century have been the development of the halfpenny morning paper, and the enormous number of illustrated newspapers that have been started, together with the brilliant improvements in their production. It was Herbert Ingram who first appreciated the fact that an illustration, however rough, increased the sale of a newspaper, and it was this that caused him to start, in 1842, the *Illustrated London News*. For very many years all illustrations were produced by wood-engraving, but about the year 1866 a change took place. Whereas formerly all drawings had to be made upon wood, the artists were now able to make their drawings on paper, and these were photographed on wood and engraved, but still larger changes came about when "mechanical" or "process-engraving" was introduced.

As early as 1814, Niepce commenced experiments with photo-engraving, and actually, in 1824, produced proofs from a photo-etched plate, but it was not until the days of Gillot that, what is commonly called "process-work," became universally used. The earliest public recognition of the new process was at the 1855 Exhibition, when the distinction of honourable mention was conferred upon it. Some years later, in 1882, Meisenbach patented his new process, by means of which wash-drawings could be reproduced by what is called the "half-tone process." This means of reproduction came rapidly into fashion, and it sounded the knell of wood-engraving.

About the middle of the century, rotary printing machines commenced to be used, and then followed various ingenious inventions by which the type-metal is melted, cast, and set in type, in lines and columns, and each nights' metal thrown in the melting pot for next day's use. The paper was automatically cut to the required size, &c., until at last we have machines which cut, fold, stitch, and even count and deliver the papers in quires.

What is to be the outcome of this feverish competition? We have too much manufactured news—too much desire to anticipate our contemporary; too much diplomacy to filch and print confidential documents; too much crankism, too little judgment, too much reporting. Much talk would cease in higher places if shallow rubbish were excluded more from the columns of the papers.

Wonderful as our press is as a purveyor of news and an example of the art of printing, it has much room for improvement as the director of public opinion. The days of anonymous leader writers are numbered. We have on our breakfast tables now verbatim reports of the views of the men of light and leading. To my mind the *Daily Graphic* is the type of the 20th century daily paper.

Magnetism.—Although the main facts of the action of magnets upon each other were known to the Chinese, the Greeks, and the Romans, before the Christian era, yet no attempt to utilise these facts for navigation or surveying purposes in Europe, was made before Marco Polo returned from the East in the 13th century. Columbus used the mariner's compass to cross the Atlantic in 1492, and discovered that the magnet does not always point in the same direction; but that this declination of the needle varies in different longitudes, and in one place coincides with the geographic or true pole. Gilbert, in 1600, made the first scientific research into its facts and laws, but little was done to remove the defects of the needle, and to develop its functions, until Ampere, Gauss, Faraday, Biot, Airy, Fox, and Lord Kelvin brought their theoretical and practical minds to bear upon the subject in the 19th century. Now every error introduced by iron and steel, so largely used in the building of ships, and magnified by position and hammering in construction has been removed.

The hammering action of the sea, the heeling of the ship, the motion of the machinery, and the stowage of disturbing cargo is corrected by iron masses and permanent magnets placed in different positions about and near the compass, and the safety of the ship assured. Not only has our knowledge been extended by magnetic observatories like those of Greenwich, Kew, and Falmouth, but the education of the navigator in this respect is encouraged in our navy by the enforced possession of certificates of proficiency in magnetic science and practice by our navigating officers. Our mercantile marine should follow suit. The knowledge of the causes of errors means their removal.

Local disturbances have been experienced in shallow water when passing over magnetic rocks. At Cossack, in North-West Australia, H.M.S. *Meda*, in eight fathoms, three miles from shore, found a variation of 30°.

The only excuse for disaster due to magnetic disturbance is ignorance. The stars are always with us for guidance and comparison. Magnetic science must be maintained by well equipped laboratories, by continuous observations, by the distribution of reports, and by up-to-date records and corrections of charts. We seem to have learnt all we can of magnetism, and we commence the 20th century without any indication of a new directing force. We have local magnetic disturbing elements to measure, and certain dangers due to storms, snow, rain, and fog to remove. We want better warning of approach to land, and better communication between ship and ship and ship and shore. The 20th century is bound to see great developments in this direction.

International joint action promising simultaneous uniform and careful observation over all the globe is about to commence with the coming year. All the nations are going to unite to conquer the mystery of the disturbances of the mariner's compass. When will religion and politics do what science has done?—gather together in one fold all the nations of the earth to follow one fixed purpose on one matured plan to fathom the deepest caves of Nature's ocean.

Traction.—Electrical energy has opened to us a very wide field in the facility it affords to economise and to facilitate *traction.* It is utilised for working tramways, railways, and automobiles. Tramways are simply improved roadways. Our towns increase in size, the population extends furthur and further outwards, streets become too narrow, roads inefficient, and traffic becomes congested. The main thoroughfares spread outward too far from each other. Hence new arteries are needed, cross connections become necessary, roads must be widened, and streets supplemented, either above or below, with relief tracks for vehicular and pedestrian traffic. In dense districts and thronged streets like Piccadilly, the Strand or Cheapside, streets must remain streets. London is a crying example of the neglect of our immediate predecessors to foresee coming wants. This subject was thoroughly dealt with by Sir John Wolfe-Barry (as Chairman of the Council) in his two addresses. I can simply endorse his views by pointing out how electricity steps in to act as a panacea. Tramways worked electrically carry people to and from their dwellings and business places with comfort and celerity. Their success has been phenomenal. Rapid transit, frequent service, and cheap fares are the secret of this success. Their success also shows their necessity. They enable the vexed question of housing the working classes to be met. Cottages and cheap artisans' dwellings can be erected in the open country where land is cheap, and where dwellers, removed from close, confined, and congested tenements and slums, can breathe pure air and inhale new health.

All roadways should be made wide enough to accommodate two tramway tracks, to leave room for up and down light and heavy vehicular traffic, room on each side for stopping vehicles, as well as ample footways for pedestrians.

New York has constructed elevated railways which are successful but ugly, and restrict the old street below; but Boston, U.S.A., has done what London would have done eleven years ago but for the opposition of the London County Council, who threw out the

Bill before Parliament in 1889, but who now have learnt the error of their ways, and are promoting such subways themselves. There is an admirable electric subway in Budapest.

Low-level tubes 60 feet down are a great mistake for local traffic; for express traffic they are admirable. The metropolitan railways, when converted to electric traction, will, from easy access, recover their traffic.

Liverpool, in its Mersey Dock Railway, the City and South London Railway, the Waterloo and City line, and now the Central London ("The Twopenny Tube") have shown how simple it is to work railways by electric traction. England is ahead of the United States in working railways electrically. All our main lines are carefully considering the subject, and the 20th century will see an immense development of the working of suburban traffic by electric traction.

The new alternate current system which has been devised by Messrs. Ganz, of Budapest, is a distinct departure of great merit, and promises to enable us to acquire great speed at considerable economy.

A high speed railway to run express trains at 110 miles per hour, has been projected between Liverpool and Manchester. This is to be constructed on the monorail system devised and advocated so warmly by Mr. Behr.

The Germans are experimenting in the same direction, between Berlin and Zossen, but on an ordinary birail line, and with an alternating current system. They have already attained 100 miles per hour. It would appear that the same principles of high speed, frequent service, cheap fares and light trains, will enable our great railway companies to recover their financial position, not only by increasing their receipts, but by diminishing their working costs. The alternate current system has arrived to enable this to be done. The 20th century will see a great revolution in the working of railways. We want only a recovery of financial confidence in electrical enterprise.

Automobiles are the rage of the day. The fashion has taken some time to reach England, but now motors grunt and smell everywhere. They are very exhilarating to ride in, and certainly give great prospects of utility. Oil engines are in the ascendant, but steam promises to look in for heavy loads. Electricity will, however, ultimately be the favourite when the real battery appears, which it is certain to do in the 20th century, for electricity is silent, it is odourless, and it is effective.

It is impossible in the time at my disposal to extend the survey further. Agriculture, chemistry, sanitation, mechanical mining and civil engineering generally have all followed the same programme, and deserve the same treatment. I should like to have dealt with the growth of harbours and docks, and the rapidity of change going on in the dimensions of ships and the number of ports. Rapidity of loading and unloading ships is the soul of modern business. The introduction of electrical appliances to effect this is increasing at a great pace and pressure. Ships, naval and mercantile, is another large subject sufficient for one single address. It is a misfortune that our country is losing the services of Sir William White, the maker of the present fleet of Great Britain, and this owing to health shattered by anxiety and overwork.

It would seem that by some strange coincidence a wave of enlightenment in all that affects human happiness and welfare has flowed over this country, commencing with the accession of our late beloved Queen. The Victorian era will be the brightest page of English history. It is still flowing with undiminished amplitude and strength at the commencement of the reign of our late President and present Patron, His Gracious Majesty King Edward the VII. This applies not alone to engineering and industry, but to art, religion, morals, and politics, all of which are on the upward trend. The love of art is extending to lower grades of the social scale, and is served by improved means of reproduction and illustration; religion is less virulent in its sectional differences, and higher criticism is less bitter and more tolerant; morals are greatly improved in their tone, though wider circulation of news occasionally leaves an opposite impression. Politics is still the least advanced of all our sciences, even of those sciences which come within Huxley's definition of "systematised and organised common sense." Politics is the most popular, the most noisy, and the least efficient of them all. The waste of energy in this field could not well bear the inspection of a balance-sheet. The work done on the credit side is often a minus quantity—it is always very minute. What pleasant reading a morning paper would be if all the politics were excluded, but where would be its circulation? It is an anomaly that a science of which we are absolutely ignorant should command the attention and thought of nearly all, and that the same facts should excite exactly opposite opinions in the minds of every alternate man we meet.

I hope that I have succeeded in showing that progress in all branches of life is due to certain motive causes working on the principle of evolution; that these causes are within the reach of our observation; and that they have only to be discovered, so that, by their encouragement, we may secure, during the coming century, greater and further advances in civilization and knowledge.

After delivering the Address the Chairman presented the Society's medals which were awarded for papers read during last Session.

For papers at the Ordinary Meetings :—

To Major RONALD ROSS, F.R.S., for his paper on "Malaria and Mosquitoes."

To Dr. W. SCHLICH, C.I.E., F.R.S., for his paper on "The Outlook for the World's Timber Supply."

To Lieutenant ARTHUR TREVOR DAWSON, late R.N., for his paper on "Modern Artillery."

To FRITZ B. BEHR, Assoc.Inst.C.E., for his paper on "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester."

To PERCY R. MACQUOID, R.I., for his paper on "Evolution of Form in English Silver Plate."

To Professor RAPHAEL MELDOLA, F.R.S., for his paper on "The Synthesis of Indigo."

To Sir JOSHUA FITCH, LL.D., for his paper on "School Work in Relation to Business."

To GUGLIELMO MARCONI, for his paper on "Syntonic Wireless Telegraphy."

In the Indian Section :—

To HENRY JOHN TOZER, M.A., for his paper on "The Growth and Trend of Indian Trade—A Forty Years' Survey."

To Colonel Sir THOMAS HUNGERFORD HOLDICH, R.E., K.C.I.E., C.B., for his paper on "The Greek Retreat from India."

To JOHN DAVID REES, C.I.E., for his paper on "Madras, the Southern Satrapy."

In the Colonial Section :—

To the Hon. Sir JOHN ALEXANDER COCKBURN, K.C.M.G., for his paper on "The Commonwealth of Australia."

To Lieutenant CARLYON W. BELLAIRS, R.N., for his paper on "The Coal Problem: its Relations to the Empire."

In the Applied Art Section :—

To WILLIAM BURTON, F.C.S., for his paper on "Recent Advances in Pottery Decoration."

To HUGH STANNUS, F.R.I.B.A., for his paper on "Some Examples of Romanesque Architecture in North Italy."

Sir FREDERICK BRAMWELL, Bart., F.R.S., in moving a hearty vote of thanks to the Chairman for his address, said that although he did not agree with all Sir William's views, he thanked him for his extremely valuable Address, and the way in which he had contrived, in so small an available space, to give a general review of much that had taken place in the last century. The Chairman had remarked that he would not go down to his grave happy until he had travelled at 150 miles an hour. If Sir William fell down a coal pit 784 feet deep, by the time he reached the bottom he would have attained a velocity of 150 miles an hour, and would certainly go to his grave. He believed that the mechanical balance-sheet, of which he was the author, had been of very great use in arriving at the true facts of the values of different fuels for different boilers and engines.

Sir STEUART BAYLEY seconded the motion, which was carried unanimously.

Sir WILLIAM PREECE, in reply, thanked the members for the cordiality with which Sir Frederick Bramwell's proposition had been carried. Sir Frederick had succeeded the late Prince of Wales as President of the Society, and he sincerely hoped that he might be succeeded by another Prince of Wales, although he trusted Sir Frederick would long remain among them to promote the interests of the Society.

Miscellaneous.

SMALL SCREW GAUGE.

Report of the Committee, consisting of Sir W. H. Preece (Chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-Gen. Webber, Col. Watkin, Lieut.-Col. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, E. Rigg, C. V. Boys, J. Marshall Gorham, O. P. Clements, W. Taylor, Dr. R. T. Glazebrook, and W. A. Price (Secretary), appointed to consider means by which practical effect can be given to the introduction of the screw gauge proposed by the Association in 1884.

The Committee report that the present condition of the matter submitted to them is as follows :—

In the report presented at the meeting of the Association which was held at Bradford, in 1900, it was recommended that the shape of the thread of the British Association screw gauge for the use of instrument makers should be altered in the following particulars for all screws from No. 0 to No. 11 inclusive.

For Screws.—That the designating numbers, pitches, outside diameters, and the common angle of 47½° remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in sections, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being in consequence diminished by one-fifth of the pitch.

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* For previous reports see *Journal*, vol. 31, 115; vol. 32 p. 1016; vol. 47, p. 808; vol. 48, p. 805.

For Nuts.—That the designating numbers, the pitches, the diameters of the clear holes, and the common angle of $47\frac{1}{2}°$ remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch.

The effect of these alterations is as follows:—

The threads of the screws and taps are of a very simple form, being cut with a single point tool or grinding wheel, with straight sides and a flat top, and the top of the thread is part of a cylinder. Though the form of the bottom of the thread depends on the correct grinding of the end of the tool, great accuracy is unimportant, as the screws and nuts do not come into contact there.

The threads of the nuts and ring gauges will be accurate in proportion as are the taps used to cut them, the edge of the thread forming the through hole being part of a cylinder.

The actual differences between the screws and nuts of the old form and that recommended are so small, that it is believed the old stocks will in practice be interchangeable with the new screws, so that the amount of inconvenience caused by the change will be exceedingly small.

The British Association screw gauge has been in use in England for seventeen years. Many firms in England have originated the threads and constructed gauges for sale or for their own use, but the difficulty of producing them is great, and the market obtainable may have been insufficient to induce them to perfect the processes necessary for making them accurately interchangeable. In short, the British Association screw gauge of 1884 was of too complicated a form to allow of its accurate realisation except at a cost which has proved prohibitive.

That very accurate gauges with rounded threads can be produced is not disputed, but the difficulty of doing so for small screws is very great. The names of three firms in America, and of one in Germany, have been proposed to the Committee as being competent, and probably willing, to undertake the production of gauges and tools of the rounded thread. The Birmingham Small Arms Company, who produce interchangeable work on a very large scale, and to a high degree of perfection, use only round-topped screws, fitting all over, for bicycle work; and Mr. Clements exhibited gauges used by that firm illustrating his paper read before the Section at Bradford. This firm does not produce these gauges for sale. The American firm of Pratt and Whitney have manufactured a large number of sets of gauges and screwing tools for the English Government, but declined to submit these to the Committee on the ground that they were not sufficiently accurate to satisfy us. After long delay, they submitted to us three specimens, which were reported upon by this Committee at the Dover meeting. Though the best we had seen, they were distinctly inferior to the screws used in the ordinary micrometers purchasable in tool shops, which have threads of the character which this Committee has recommended for adoption.

While the round thread is only produced satisfactorily by a very few firms, who have made a special study of this class of work, the Committee believe that the form of thread they have proposed can be made in any fairly equipped tool-room; and that this facility in producing or obtaining the necessary appliances must very greatly encourage the maintenance of and accurate standard in small screws, to promote which has been the object in the view of the Committee. If, on the other hand, these tools and gauges are very special, and perhaps costly, appliances, obtained only by the refined processes of certain factories, their use in workshops will extend slowly. The Committee aim at putting the matter on such a footing that the common everyday appliances in the hands of workmen shall be of a good order of accuracy, and this is only possible if they are produced easily and cheaply.

It is not suggested by the Committee that the form of thread recommended is the best for all purposes, and for all sizes of screws, and they have expressly excluded sizes of screws below No. 11 British Association gauge, which are produced by pressure and not by cutting. Their recommendation applies only to the screws used in instrument making and similar trades for assembling parts, of which screws a large proportion, perhaps 95 per cent., are of brass. Considerations affecting the use of screws for other purposes have been put before the Committee, especially by Mr. Clements in the case of bicycle and gun screws, and by Mr. Taylor in the case of lens screws. These have thrown suggestive light on the question before the Committee, and will be closely considered by them if re-appointed.

Since the last report the Committee's proposals have attracted much attention, but no sets of gauges or tools of the new thread have been submitted to them, and so far their recommendation has had no practical result. They are informed, however, that one firm of manfacturers in England is occupied in producing tools and gauges for their own use, and if they succeed in producing them of satisfactory accuracy will submit them to the Committee.

Mr. O. P. Clements, the author of a paper on screw threads used in bicycles, read before the Section at Bradford, has been elected to the Committee.

Mr. W. Taylor, who has taken a leading part in the standardisation of the screws of photographic lenses, and has been in communication with the Committee, has also been elected a member.

Dr. R. T. Glazebrook has been elected a member of the Committee.

Correspondence has passed between the Committee and Dr. R. T. Glazebrook, the Director of the National Physical Laboratory, respecting the examination of screw gauges, and the following arrangements have been made:—

The National Physical Laboratory will undertake to examine and to report upon gauges of the British Association submitted to them.

The Committee have applied the grant of £45 made to them at Bradford to the purchase of apparatus for the examination of gauges by the National Physical Laboratory, and have appointed Mr. C. V. Boys, Lieut.-Colonel Crompton, Dr. R. T. Glazebrook, Mr. W. A. Price, and Col. Watkin to be a Sub-Committee for the expenditure of the grant. The Committee are of opinion that the previous grant of £45, made in 1900, will be insufficient to purchase the necessary apparatus, and recommend their re-appointment with a grant of £45.

Obituary.

Alfred Harris.—Mr. Alfred Harris, the well-known banker of Bradford, a member of the Society of Arts of forty-four years standing, died on Tuesday, 14th inst., after a short illness, at his residence, Wharfenden, Farnborough, Hants. He was born at Stoke Newington on July 6th, 1826; the son of Mr. Edward Harris, ship-broker, of London. In 1850 he went to Bradford to join his two uncles in their bank, which had been founded in 1803 under the style of Peckover, Harris and Co. In 1864 the firm was incorporated as the Bradford Old Bank (Limited), and in 1882 Mr. A. Harris became chairman of the company, and continued in that office until last year. One of his first works as chairman was the development of the "branch" system, by which all important districts of Bradford were provided with local banks. He was also chairman of the Leeds and Liverpool Canal Company. He took much interest in educational matters, and was an amateur artist. He assisted in the formation of the Bradford School of Art, and also in the foundation of the Local School of Design. In 1885 he filled the office of High Sheriff of Westmoreland.

General Notes.

Utilisation of Pine Needles.—In the Oregon exhibit in the Agricultural Building of the Pan-American Exhibition at Buffalo is an interesting display of methods of utilising pine needles, as employed by an establishment in Grant's Pass, Oregon. The American *Manufacturer*, in a recent issue describing this process, says that the company takes the long needles and puts them through a process of steaming and rolling, after which they look like coarse hair or tow, and are said to retain all their original medicinal properties. This peculiar woolly fibre is utilised in a great variety of ways. From it is obtained the extract called "Pinaroma." Bonbons are also made with the original pine flavour, and these are said to be not only palatable, but wholesome as well, and are used as a specific for many complaints. Pine pillows, stuffed with the soft fibre, find a ready sale, and underclothes and hosiery knitted from this vegetable wool are said to be an excellent remedy for, and preventive of, rheumatism, and also to be valuable for the use of those suffering from pulmonary troubles. Cigars are also manufactured with this pine material for a filler, and with a regular tobacco wrapper, and are stated to have a beneficial effect on the throat and lungs of those who smoke them.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) William Jago, "The Chemistry of Confectioners' Materials and Processes." (Lecture I.)

National Indian Association, in the Jehanghir-hall, Imperial Institute-road, S.W., 4½ p.m. Dr. M. L. Dhingra, "Indian Sanitation: a Personal View."

Imperial Institute, South Kensington, S.W., 8½ p.m. The Hon. H. B. Lefroy, "Western Australia."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn Hall, Holborn, E.C., 5½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Messrs. W. Höfler and H. L. Ashford, "Hammered Metal Work."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Charles Stewart, "Nourishment and Protection of the Young of some Animals."

Tuesday, Nov. 26...Medical and Chirurgical, 20, Hanover-square, S.W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. A. F. Aspinall, "Train Resistance."

Photographic, 66, Russell-square, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Northumberland-avenue, W.C., 4½ p.m. Mr. W. Gibbons Cox, "The Water Supply of Australia."

Wednesday, Nov. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. J. Gordon Parker "Leather for Bookbinding."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m. Mr. Samuel Davey, "The Letters and Prose Writings of Robert Burns."

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Thursday, Nov. 28..Irish Literary (at the House of the Society of Arts), 8 p.m. Miss Eleanor Hull, "St. Columba."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. Tredeman, "Hungary as a field for British Enterprise."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. T. C. Hepworth, "Divers and Diving Operations."

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FRIDAY, NOVEMBER 29, 1901.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, December 2 (Cantor Lecture), 8 p.m.—William Jago, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." (Lecture II.)

Wednesday, December 4, 8 p.m.—Herbert Stone, "The Identification of Wood, and its application to Scientific and Commercial Purposes."

Thursday, December 5, 4.30 p.m. (Indian Section).—Edward Penton, B.A., The New Trade Route to Persia, by Nushki and Seistan.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 25th inst., Mr. William Jago, F.C.S., delivered the first lecture of his course on "The Chemistry of Confectioners' Materials and Processes." The lectures will be published in the *Journal* during the Christmas recess.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 27, 1901; Richard Garnett, LL.D., C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Barnett, Joseph, Erskine Chambers, Lincoln inn-fields, W.C.
Clarke, R. F. D., care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.
Falk, Salomon, Messrs. Falk, Stadelmann and Co., Limited, 83 to 87, Farringdon-road, E.C.
Gilkes, Edward, 205, Charlotte-street, Lacytown, Georgetown, Demerara, British Guiana.
Hodgkinson, Thomas Ayscough, 11, Bedford square, W.C. and 3, Queenhithe, E.C.
Höfler, William, 26A, Soho-square, W.
Lamb, Lieut.-Col. Thomas, 8, Claverton-street, S.W.
Lebbe, A. R. Casse, 1, Trincomalee-street, Kandy, Ceylon.
Maskelyne, J. Nevil, Royal Artillery Mess, Shoeburyness.
Ochs, Albert Lionel, 25, Green-street, Park-lane, W.
Sainsbury, Stafford Fox, 136, Regent-street, W.
Sinah, Rai Bahadur Shanker Dyal, Kesath Dumraon, Shahabad, India.
Shillitoe, Thomas, Beodericsgueorth, Bury St. Edmunds.
Stewart, Angus Matheson, Sanchez, San Domingo, West Indies.
Wilkins, Frederick John, 11, Kensington High-street, W.

The paper read was—

LEATHER FOR BOOKBINDING.

By Dr. J. Gordon Parker.

For many years past there has existed a growing dissatisfaction among librarians and owners of libraries with the quality of the leather put on books, owing to the fact that many books bound within comparatively recent years already show serious signs of deterioration and decay. This dissatisfaction grew in volume until a small committee of gentlemen interested in the subject called together by Mr. Douglas Cockerell under the chairmanship of Mr. Cobden Sanderson, began to investigate some of the causes, and to take evidence on the subject. At this committee a certain amount of information was gleaned, but it was found generally that the exact causes of the decay were not known. Librarians were inclined to lay a good deal of the blame upon the bookbinder, who in turn blamed the leather merchant for the quality of the leather, and the leather merchant when questioned absolved himself of all blame by vaguely talking of new processes of tanning, even hinting as to the existence of some rapid process of transforming skin into leather by aid of acids and other chemicals.

After this, which I may term a preliminary enquiry, the Society of Arts took the matter up, determined that if possible the cause of the dissatisfaction should be investigated. To this end a very strong committee was appointed, under the chairmanship of Lord Cobham, and the members included representative bookbinders, librarians, leather merchants, leather manufacturers, and chemists who made a special study of the leather trade. Of this committee, I formed a humble member, and as a member of both sub-committees which were subsequently formed, as well as of the main committee, I have been asked by several to detail the various investigations which were carried out by the sub-committees, to show samples of the leather which was used and tested, and to give the actual proof and experimental work in detail on which the main committee based its report, which has now been before the public for some months.

I need hardly enlarge upon the work of the first sub-committee, whose object was to justify the cause of the complaint, to find out which leathers appeared to decay most rapidly, and the conditions under which the books were kept, whether the decay was noticed as much in libraries lighted with gas or electric light, whether the bindings appeared to last longer when kept under glass cases, and if possible to note approximately the period at which general decay seemed to set in. This committee in its work visited nine of the most valuable and most important libraries in England, and found generally that most modern leather of all kinds showed signs of decay, and in many cases that bindings of not more than ten years already showed marked signs of deterioration and decay. The bindings of scientific works, proceedings of learned societies, on shelves, bound in calf, of which the date of binding could be very closely ascertained, were in many cases falling to pieces, and in several cases books bearing the dates of 1885, 1886, and 1887 could not be handled without the leather coming off in the form of dust. In another case the removal of the book from the shelf caused the back to come right off.

Generally speaking, as the report clearly states, most sign of decay was found in libraries where gas was used for lighting; and it was also found that, approximately, the most marked form of decay was noticed from 1860 onwards. It was certainly noticeable on books bound at any earlier period, but it became more general, comparing all libraries, about 1860.

Through the extreme kindness of several of the librarians and bookbinders I was allowed to detach portions of many of the worst specimens, in order that they might be laid before the second sub-committee for microscopical and chemical examination. This second sub-committee was also supplied with many old bindings and with various samples of bindings, the exact date, nature of the leather, and all particulars being clearly stated.

Turning now to the work of this second or scientific sub-committee, the problems before them were, therefore, of a definite nature. Having first convinced themselves of the almost universal tendency on the part of modern leather to decay, their work was to investigate the cause or causes of this modern decay, and to find out why books which were bound in the 15th to the early part of the 19th century were still in most cases in almost perfect condition. It was extremely unlikely that any change had taken place in the nature of the raw skins used. It was consequently taken for granted that the causes were to be found in some of the modern processes of leather manufacture. An examination of several pieces of old bindings revealed the fact that the bindings were, generally speaking, thicker than those of more modern date. A microscopical examination showed the fibres of these leathers to be in an upright condition, whereas in more modern leather this is not generally the case; the stretching and tight setting-out of the skin having a tendency to lay the fibres in a more parallel state. Another important factor was revealed by the chemical analysis, which showed that all the old samples of leather analysed contained less tannin in proportion to the skin substance than was found in more modern bookbinding leather; in other words, it was evidently the custom in the 18th and 19th centuries to tan the skins in weaker liquors, with the result that the leather was lighter tanned than is the custom at the present time.

Further, and also another important factor was, that in most of the bindings examined which had stood the test of time the tanning material which had been used was in nearly every case either sumach or oak bark, and it was further noticed that in many cases where even fairly modern leather had stood for twenty or twenty-five years the tanning agent had been sumach. Here, therefore, there was indicated a special line of investigation likely to be productive of much useful information. Although sumach and oak bark are still used for the tanning of the better-class high priced leather, very many skins are tanned with such materials as quebracho (a wood which comes from South America), larch bark, gambier, and mimosa bark, and thousands of dozens of sheep, goat and calf skins are sent over ready tanned from India. These latter are tanned with turwar bark, *cassia auriculata*. These are known in the trade as Persian moroccos, Persian sheep, and E.I. calf. Some of these skins are simply scoured, dyed, and finished; while the majority are stripped of the loose tannin by scouring in a weak alkaline bath, borax or carbonate of soda being used. As this treatment turns the skins an ugly dark brown colour they are put into a bath of weak sulphuric acid. When supposed to be thoroughly freed from sulphuric acid by washing in water, they are retanned with sumach, and afterwards dyed and finished in the usual manner.

In order to find out whether any special tanning material had or had not an advantage, and whether the tanning material, *per se*, was liable to cause decay or destruction of the leather, calf, goat, and sheep skins were tanned out, one of each skin in each of the following tanning materials: pure sumach, pistacia lentiscus, tamarix, oak bark, myrobalanus, quebracho, mimosa bark, gambier, larch bark, chestnut extract, and oakwood extract. Two sets East India tanned goat, sheep and calf, one set washed, oiled and dried, the other set scoured, soured and sweetened and retanned in sumach as carried out in practice, were also prepared. When these skins were judged to be lightly but thoroughly tanned, one half of each skin was removed from the tan liquor, and the remaining halves were left in the liquors, these being strengthened up with more tannin, so that the second halves were more fully tanned, as is most commonly the case in modern leather. The leathers so produced were rinsed through water to remove superfluous tan, allowed to drip, and when in a semi-dry condition were oiled lightly upon the grain surface, and hung up and dried in the usual manner. Portions of these skins are before you on the table. Pieces of each of these leathers were so fastened upon boards that one half of the piece of leather was exposed, while the other part was carefully covered, so as to be protected from either light, heat, or the action of the surrounding atmosphere. In all, eight such duplicate sets were arranged, and were subjected to the following tests for thirty days;—

Board No. 1 was exposed to an ordinary direct sunlight. This was done in a large room facing south, and the tests were carried out during July and August.

The second board was exposed to the action of gas-light. A small cupboard was arranged, and a No. 5 ordinary fish-tail gas-burner was placed in the centre of the cupboard, and the boards so arranged round this that the leathers were about 18 inches from the lighted burner.

No. 3 board was arranged in a similar cupboard, and exposed to the light from an ordinary incandescent gas-burner.

No. 4 was also arranged in the same way, but in place of the gas-burner, a 16-candle power incandescent electric lamp was used.

The fifth board was subjected to the fumes of burnt gas. To carry out this experiment a similar room was used 8 ft. high and 6 ft. square. On the floor of this room was placed an ordinary fish-tail burner, turned about half on, and the boards, with the leather fixed upon them, were hung on the ceiling. A maximum and minimum thermometer was also hung on the ceiling, and the room so ventilated that the temperature was not allowed to exceed 90° F. I may add that this was the temperature noted on the top shelves of two of the libraries which were examined, so in this case the worst library conditions were imitated as closely as possible.

The sixth board was subjected to moist and dry air alternately. This was done by drawing a current of moist and dry air over the leather through a vacuum oven. The temperature was kept at 60-70° F.

The seventh board was subjected to an atmosphere of carbonic acid gas. This test was likewise carried out in an oven, the carbonic acid gas being dried before it was allowed to enter the bath.

The eighth board was subjected to direct sunlight, but the leather was protected from the air by a sheet of glass being laid upon it. This was exposed at the same time, and in the same room as board No. 1.

The leather after this treatment gave some most interesting and instructive results. It showed:—

1. That the leathers tanned with certain tanning materials were less affected than those tanned with other materials.

2. That the fumes of burnt gas appeared to act more strongly on all the leathers than any other agent.

3. That artificial light had only a slight

effect upon the leather, provided it was protected from the products of combustion.

4. That direct sunlight and air appeared to have a very strong disintegrating action upon most of the samples, but when the leather was protected by a covering of glass the action was less intense.

5. Moist and dry air appeared to have no special deteriorating action. The same thing was noticed in the set exposed to carbonic acid gas. The electric incandescent light appeared to have even less effect than either ordinary gas-light or the incandescent gas burner, probably on account of the less heat evolved and the absence of products of combustion.

On examining all these sets side by side it was noticed that in each case the leathers tanned with sumach were the least affected of any, followed in regular rotation being less affected by myrobalanus, chestnut extract, oakwood extract, oak bark, gambier, larch bark, quebracho, pistacia and tamarix; and the worst set was the leather tanned with turwar bark, especially the sample which had been scoured, soured and retanned. Further, it was also noted that the samples of leather which had been only lightly tanned, were less affected in each case than the samples which had been finished in stronger tanning material, and were thus more heavily tanned. These results showed that the tannins which belong to the pyrogallol class of tanning materials. viz., sumach, myrobalanus, chestnut and oakwood extracts, were the least affected; while, on the other hand, those of the catechol series, represented by gambier, larch bark, quebracho, and turwar bark, became dark red in colour and hard in texture. The fibres of the leather appeared to be disintegrated, and in the worst cases the leather could not be rubbed even with a soft cloth without removing a layer of red powder. The tannins of the catechol series appear to part readily with water when exposed to the action of light, heat, or acids, and are converted into red, resinous-like substances which appear to thoroughly disintegrate the fibres of the leather, causing it to become hard and lose all strength.

These above detailed experiments were first carried out at Wrexham by Mr. A. Seymour-Jones, and were afterwards repeated by myself in London, and both sets were confirmed by Professor Procter in Leeds, so as to leave no doubt about the accuracy of the work. A similar set was treated for sixty days, and some leathers were exposed for three full months. These samples are before you this evening, and can be examined by anyone interested. This was the first stage of the work, and it revealed clearly that tanned goods of which sumach was the tanning material were the least affected of all the tanning materials, and that the East India tanned portions were the most sensitive to either gas fumes, light, or heat.

To further test these latter goods, a fresh set of leathers was obtained. An ordinary tanned East India goat and also a sheep skin were purchased in the usual manner, and each skin divided into four parts. A quarter of each was left in its state as purchased; a second quarter was rinsed through water, lightly pressed out, oiled and dried; a third quarter was scoured in alkali, then washed through sulphuric acid, afterwards well rinsed in water and then retanned in sumach; and the fourth quarter was simply washed well in water, struck out, and afterwards retanned in sumach. These portions of skins were subjected to a similar series of experiments, to the action of gas fumes, direct sunlight, and to diffused daylight for 60 days. Each sample was more or less affected. The quarters which had been stripped with alkali, treated with acid, and afterwards sumached showed most deterioration. The portions exposed to the action of burnt gas fumes were absolutely rotten at the end of the time, and could not be handled without breaking or falling into powder. The best sample was that which had been simply washed in water, oiled and dried, but even this was badly damaged, and turned a deep red colour, but it showed that the removal of some of the tannin tended to lengthen the life of the leather; while, on the other hand, the usual trade custom of stripping with an alkali and souring with acid, afterwards retanning in sumach, appeared to about halve the already short wearing life of these leathers.

Thus far, then, the committee had discovered the best and the worst leather in its natural tanned state. The next point was, if possible, to find out the cause of the decay in modern oak barked tanned calf. For this purpose several samples of tanned calf skins were purchased and obtained from librarians and bookbinders. None of this leather had been used or exposed in libraries, and most of the samples contained varying quantities of free sulphuric acid, which had evidently been used to brighten the colour. Several other samples were therefore obtained free from sulphuric acid. Portions of each of these skins were subjected to the method of testing described, with the result that acid free leather stood the tests in a very satisfactory manner, while the other samples which contained quantities of sulphuric acid, varying from two-tenths to eight-tenths of a per cent., had changed to a red brown colour, become hard and brittle, and were easily abraded by friction.

I may say, in passing, that this custom of brightening the colour of bark tanned calf with acid, is of comparatively recent date, probably becoming general twenty or thirty years ago. It has a wonderful effect upon the leather; it removes stains or any unevenness in colour, generally brightening the somewhat reddish tone, and transforming it into one of a yellower shade, thus giving to the skin a better appearance from the buyer's standpoint. Further tests with bark tanned calf, showed that the heavier it was tanned, the more rapidly it appeared to decay.

The experiments carried out thus far, as will be noticed, were only done with the rough-tanned skins. But it was necessary to find out whether the methods of dyeing and finishing leather in any way impaired its wearing qualities. For this purpose, several kinds of skins, including calf, sheep, goat, seal, and pig, were obtained, and each skin was divided into four portions. The first portion was retained in its rough tanned state; the second portion was struck out, dyed, freed from superfluous dye by rinsing in water, and dried out; the third portion was struck out, dyed, and finished in the usual manner, being glazed after applying an ordinary albumen seasoning, and no acid being added to the dye-bath to develop the colour; the fourth portion was struck out, dyed with the addition of an ordinary amount of sulphuric acid, and finished in the usual manner. These series were, as before, exposed to direct sunlight, and to the fumes of burnt gas. The results showed at once that the dyeing of the leather where no acid had been used, did not in any way affect the life of the leather. The finishing appeared to protect the surface of the leather somewhat. This would, of course, be expected, as the ordinary finishing process consists of coating the leather over with a thin layer of albumen, and afterwards polishing either by hand or machine. This thin layer would naturally protect the tannin from oxidation, and preserve the leather for a certain time. The portions of the skins with which acid had been used in the dye-bath, however, showed signs of decay, and had become hard and brittle. Of the five different skins used, the calf and sheep appeared to be the weakest, while the goat, seal, and pig skins appeared the least affected of the five.

In order to ascertain whether the use of sulphuric acid, either as a brightening agent or in the dye-bath, had become universal, from various sources we collected a large number of samples of different kinds of leathers. I have not the details of the number of samples examined by Professor Procter, who fully confirms my results, but I personally analysed 38 different samples of moroccos, and found that 36 contained free sulphuric acid; 18 different samples of skivers were examined, of which 12 contained acid; 32 different samples of calf, out of which 27 contained free sulphuric acid; 18 Persian goat and 23 Persian sheep were also examined, and in all cases free sulphuric acid was found to be present. Six different samples of pig-skin were all tested, and in each of the six free acid was found. These were all of English manufacture, some obtained direct from the manufacturers, others from leather merchants and bookbinders.

Knowing that of recent years a large quantity of French and German skins had been used for binding purposes, eight different samples of French Levant moroccos were obtained, and in each of the eight samples a large quantity of free sulphuric acid was found; the lowest contained six-tenths and the highest 1·3 of acid. Twelve samples of German bookbinding leather were in like manner tested, and eleven found to contain acid. The highest per-centage found in any was ·85 per cent.

It would, perhaps, be unfair to draw a definite conclusion from the few French and German skins examined, but those which passed through our hands were certainly much inferior from the bookbinder's standpoint to any of the English skins. Although the French skins were of a bolder grain and larger in area, they were split down to such an extent that they were little better than paper, added to which a higher per-centage of acid was found in this class of goods than in any of the English samples.

It is evident, therefore, that sulphuric acid is of almost universal use, either as a brightening agent or to liberate the dye in the dye-bath.

As it is always customary in tanyards to rinse the skins well through water after souring with acid, it was somewhat surprising to find such a high per-centage of free acid still present in the finished leather. Tests were therefore undertaken to ascertain the amount of washing or rinsing necessary to remove the acid. To this end, several pieces of skin were treated with known quantities of sulphuric acid, and then washed for varying periods in running water. It was found to be practically impossible to remove the whole of the acid by rinsing or washing in ordinary water. One piece of "Persian" leather, containing 1 per cent. of sulphuric acid, was washed for five days and nights in running water, and at end of that period it was found that it still contained slightly over two-tenths of a per cent. of sulphuric acid, showing that sulphuric acid, as stated in Prof. Procter's Cantor Lecture, delivered before this Society, appears to dissolve in the leather and adheres most tenaciously to the fibres. It was, however, found that if skins were washed in water containing either potassium or sodium lactate or acetate, the free sulphuric acid was neutralised; where, therefore, it is absolutely necessary to use sulphuric acid the committee recommend that this means of neutralisation be adopted.

The committee then turned their attention to the various processes of tanning. Without wearying you with all the details of the experiments made, I will merely state that it was found in general that skins which had come from abroad preserved in salt were when tanned weaker in texture than either dried or fresh skins. Skins which were in any way tainted, or even only slightly decomposed, were extremely weak.

Many sheep skins arrived in this country from New Zealand and Australia in what is known as the pickled condition. These skins are pickled in a solution of salt and sulphuric acid. Several of these skins were tanned and compared against unpickled skins, and it was found that the leather produced from skins which had been pickled was much inferior in strength and durability to the unpickled.

Low liming and the use of stale limes containing quantities of free ammonia, were found to weaken the pelt, as also over-puering, a process which is used to rid the skin of lime, and, at the same time, to pull down its thickness, and to make it soft and pliable.

Many of the finished leathers examined microscopically by us showed that the skins had been distinctly over-puered. This was very noticeable in a series of pig-skin bindings of one of the large public libraries.

Another interesting feature, already referred to, was that leather appeared to lose in strength and durability the more heavily it was tanned, and this point is one which leather manufacturers should watch. I am of opinion, as expressed in the report, that the skin for bookbinding purposes should be lightly but thoroughly tanned; not what would be termed "dead tanned." They should then be rinsed lightly through water, should not be tightly set out, and should not be dried in a stretched condition. It is the custom to dry many kinds of leather strained tightly over boards. This tends to lay the fibres in a flatter and more parallel condition, and to keep the fibres all taut, removing from the skin its elasticity and also what I may term the cushion effect which is produced when the fibres run transversely to the skin.

Many of the different samples examined, both on and off books, were found to be shaved down or split so that only the thin grain surface remained. It required no investigation to prove that this was contrary to all reason, and that shaving the skin down to the thin substance could not but reduce the leather to about the level of brown paper as a binding agent.

Mr. Douglas Cockerell was good enough to obtain for me from different sources sets of samples of six different substitutes for leather for bookbinding purposes. It would be better for me on this occasion not to mention the names of these substitutes, although they are all well known to bookbinders. These mostly consisted of cloth or cotton foundations, covered over with some material of a waterproof nature, which by skilful processes could be made to imitate almost any class of skin. These samples were each subjected to a series of tests similar to those that the leathers had undergone, and although sunlight or artificial light appeared to have little or no effect upon these substitutes, they were more easily affected by the fumes of burnt gas than even the poorest qualities of leather. Moreover, in dry atmosphere they become hard and somewhat brittle.

Examination was next made of some of the methods used by bookbinders for brightening the leather and for sprinkling, and also of the pastes which were employed by them in their workshops. To this end the committee were willingly supplied by various binders with samples of sprinkled leathers and treed calf, also samples of leather which had been washed with oxalic acid to brighten the colour. It was found that sprinkled leather soon went into holes, and leather which had been washed with oxalic acid also rapidly darkened in colour, and became very hard and brittle when exposed to the sun's rays.

The pastes on the whole were found to be harmless, but from the leather standpoint we cannot too strongly emphasize the damage which must be caused to the leather by stretching it out too tightly over the back of the book in binding.

Before concluding this somewhat lengthy account of the different series of experiments carried out, I would point out one fact which at first was somewhat puzzling. We found that sumach-tanned leathers in every case stood all the tests better than any other, but that some samples of sumach-tanned leathers deteriorated, while others showed no sign after even sixty days of sunlight. On examining carefully the leathers referred to it was found that some of the rough-tanned sumach skivers contained free sulphuric acid. As the source of supply in two cases was known, the firms in question were written to, and it was acknowledged that a small quantity of sulphuric acid had been put in the sumach tanning vats to give the skins a slightly thicker feel.

But another cause for the differences in sumach-tanned leather is the fact that cheap brands of sumach are invariably adulterated with the leaves of two other materials, viz., pistacia and tamarix, and it was to the presence of these adulterants which caused some of the sumach-tanned leathers to show deterioration. This discovery led us to tan out skins with tamarix and pistacia, in order to see how they behaved in comparison with sumach tannage, and as the first series of experiments showed, they were considerably worse than even larch or gambier-tanned skins.

It was our duty to give if possible some advice to librarians and others as to the preservation of books bound in leather, and Professor Procter undertook an elaborate series of experiments with glasses of various tints in order to find out whether the disintegrating effect of sunlight could be minimised by the use of lightly tinted glasses. His experiments were eminently satisfactory. He found that the violet or actinic rays which affected photographic printing paper also affected the leather, so that any glass which would keep out the actinic rays could be recommended for the glazing of library windows.

I have endeavoured to state as clearly as possible the details of the chief experiments which were carried out by us, in order that the leather trade may be able to judge whether the grounds on which the report is based are sufficiently strong. Many other experiments were done, but I will not lengthen this paper by detailing them, as they were of lesser importance than the ones I have given. I need only say that every statement and recommendation made in the report, the grounds for those statements, and the experimental and practical work on which they are based, were confirmed by each individual member of the sub-committee, so that their conclusions cannot, as has been stated by some critics, be considered as being simply the "opinions or fads of professional men."

Before bringing this paper to a conclusion, I should like to refer to a fact that impressed us very forcibly, viz., the number of disguises under which the ordinary sheep skin masqueraded. We found books bound, nominally, in levant morocco, hard grain morocco, straight grain morocco, pig skin, calf skin, crocodile and alligator leathers; which leathers, on close microscopic examination, were found to be the ordinary common sheep skin, on which had been stamped, probably by electrotype rollers, the special grains and markings of the skins they were got up to imitate. In many cases both the bookbinders and the librarians had bought these leathers under the impression that they were buying the genuine article, the buyers having probably been tempted by the low price which would naturally be charged in a case of this sort.

The question of price brings us, I think, to one of the most important points in connection with this investigation. I may be wrong, and it may be that I am not sufficiently connected with the commercial side of the leather trade to form a definite opinion, but I venture to give my views on the subject for what they are worth. I believe that a good deal of the leather of the cheaper sort which has been found to decay is largely the fault of its cheapness. The librarian has stipulated that his books must be bound at a certain contract price. The bookbinder has, in consequence, to procure a cheap class of leather. This he has in most cases easily found, as there is always a large quantity of cheap leather on the market, splendidly finished, and to all appearances of first-class quality, which owes its high finish and good appearance to the use of materials in manufacture which are injurious to its strength. I think it is therefore clearly the duty of the librarians, if they are determined to have a leather which will last, to put in their specifications, when high-class work is required, that the leather must be of pure sumach tannage; secondly, that no mineral acids must have been used in any process connected with the manufacture of the leather; and thirdly—also an important point—that the skins used must not have been pared down or split to paper thickness. For small books, small and thinner skins must be used in the binding.

Sumach-tanned calf can be obtained and can be dyed to the brown shade so much liked in the case of ordinary brown calf; bark-tanned calf can also be used in binding, provided the leather is not over-tanned, and has not been brightened by the use of acid; but I think there is not the slightest doubt the librarians must in future, if they wish a leather to last more than from ten to fifteen years, insist on their specifications being carried out to the letter, and they must be prepared to pay a correspondingly higher price for a guaranteed article. Low quotations in most cases are to be regarded with suspicion. Chemists have now obtained sufficient knowledge to be able to test leather both chemically and microscopically (1) for the presence or otherwise of acids; (2) to ascertain if the leather is over-tanned; (3) the tanning material used, and, (4) to ascertain whether the fibres are in a good healthy condition, or whether the skin has been damaged, either in the early liming or puering, or in the later finishing processes.

I believe that in many cases the manufacturers themselves are not wholly responsible for their leather being spoilt. The buyers often demand high finishes, bold grains, and other characteristics in the leather, such as can only be obtained at the expense of its strength and durability. In many works the finishers use both alkalies and acids at different stages to produce certain results, and in nine cases out of ten they do not understand the action of the materials, and do not know that their use damages the leather. It seems to me that it would not have been necessary for this committee to sit, and for its members to spend so much time and trouble on this investigation, had the workmen, or, more important still, the leather manufacturers themselves, possessed greater knowledge of the principles underlying leather manufacture.

The work of the committee is not yet completed, as the question of the fastness of different dyes is still under investigation. The committee hope that this part of their work will be finished by next summer.

DISCUSSION.

VISCOUNT DILLON, P.S.A., said that he had not much experience of the causes of the deterioration of leather, but he was much interested in the subject, and was glad to learn that the inquiry had proceeded so far.

MR. L. DE COVERLY asked if any experiments had been made in the application of grease to leather. More grease used to be used in the finishing of leather than was now the case.

MR. ROGER DE COVERLY thought the deterioration of leather was due to the unwillingness of the public to pay a sufficient price to enable leather manufacturers to produce a good article. He was convinced that as good a leather was produced now as was ever made if people would only pay for it. He had in his possession a book bound in calf in 1841, the leather of which was in as good a condition now as when it was put on the book. The book had always been kept under glass. Books kept under glass in a temperate atmosphere would be preserved, while under different conditions they would fall to pieces. The same remarks applied to paper, as good paper being manufactured now as had ever been made, although the majority of paper in use was very little better than tinder.

MR. GEORGE PEEKE thought there was not the slightest doubt that the damage to leather was caused by the demands of the bookbinder and the public for specially prepared articles. All beautiful dyes necessitated the use of acid, which remained in the leather. The dressing of the skin in the raw state did not do half the harm that the after preparation did. He also believed that the glue, size, and paste used by bookbinders to beautify bindings, were responsible for much of the damage caused. In the present day, leather was beautified to a certain extent, but damaged very seriously. Colonel Bevington recently showed him a book bound sixty or seventy years ago in smooth calf which was in as good a condition now as when it was new. Leather manufacturers in those days did not trouble about producing beautiful tints, the consequence being that the leather lasted all the longer because it was not spoilt in the attempt to please the eye.

MR. STANLEY FLINT, as a practical bookbinder of large books in rough calf, Russia leather, and morocco, thought the decay in the leather of modern bindings was very serious. He had not been able to find a leather manufacturer who could supply him with a leather free from sulphuric acid. At a meeting of the Society of Arts some years ago hopes were held out that leather might be produced without the medium of sulphuric acid, and bookbinders would still be grateful if a more satisfactory leather could be placed at their disposal for use in their trade. He had in his possession a prayer-book bound by his predecessors in the year 1801 in the factory in which he was now carrying on his business, and the binding was in as good a condition now as when it left the shop. It was humiliating to have to confess that he could not bind as well as his predecessors of hundred years ago.

Mr. R. BIRDSALL said that after twenty years' experience as a bookbinder he fully coincided with the views of the reader of the paper, that the curse of the leather trade at the present time was the use of sulphuric acid. He came from Northampton, which was a leather town, where he had been told on the best authority that if once sulphuric acid got into the leather it was impossible to get it out again. It was possible to produce a leather that would stand all reasonable wear. First of all an honest tanner and leather-dresser must be found who must be given plenty of time, and persuaded to tan in weak oak liquor. If that process was adopted he believed as nearly as possible the same kind of calf would be obtained as that which their forefathers used three and four centuries ago. If that system were carried out the buyers must not be too particular as to the clearness of the skins, as it was almost impossible to obtain that without the use of acid. In addition, the leather-dresser must be paid a fair price for the time and trouble he had taken in producing the leather.

Mr. JOHN LEIGHTON thought the deterioration in buff calf was due to the use of oxalic acid, and that the weak point in the binding in most old books was the joint. The flaxen cords, when they were well drawn into the boards, were the only means by which a great many old books were preserved. The hot polishing iron used to obtain beautiful tree marble and mottled calf produced for the time a beautiful effect, but eventually the process ate away the substance of the binding.

Mr. GEORGE POTTER said that if fifty books bound before the year 1800 were placed side by side with fifty books bound within the last fifty or sixty years, it would be found that the latter had gone to pieces, while the binding of the older books was comparatively good. Would not a careful examination of the leather employed in both the bindings solve many present difficulties? During the active part of his business life, he was closely connected with the leather industry, and he could entirely endorse the remarks of previous speakers, that the use of sulphuric acid ruined the leather. He also believed that modern bookbinding leather would last much longer if it contained more grease. If he bought a book, the binding of which had decayed a little, he washed the leather carefully in hot water, wiped most of the moisture off, gave it a good dose of vaseline, and put it in front of the window. If by the following day it had absorbed the grease, he gave it another dose, and sometimes a third. In his opinion, the rotting of the leather and the breaking of the joints was, to a large extent, attributable to dryness.

The CHAIRMAN asked whether any special examination had been made of the books in the British Museum Library.

Mr. SEYMOUR JONES said that one of the most constantly recurring difficulties dealt with by the committee was in connection with the deterioration of the East India tanned skin. The truth had been forced upon the committee that of all the tannins sumach least readily took up the gas fumes in the atmosphere. It seemed to have more resisting qualities than any of the other tannins. There was very little doubt that sulphuric acid was used as far back as 150 years ago, because about that time a patent was granted for brightening the colours in dyeing by means of sulphuric acid, and it was probable that that method of manufacture was practised by some people. That would account for the deterioration of some of the old bindings from that period onwards. It was also of interest to know, in connection with sole leathers, that an award was granted to a Mr. McBride, at Dublin, at least 150 years ago, for a rapid process of tanning by meaas of acid. It was also known that in Henry VIII.'s time a great many Acts of Parliament were passed dealing with the subject. Leather manufacturers were bound to come to the conclusion that their present condition was entirely due to the speed at which people now lived. With the increased output of books from the huge printing-presses, and the steady demand for that literature, leather manufacturers had to face the problem of how to supply a cheap leather binding. There was a very great difference between the binding of the old and the modern book. The old binding was a work of art, but, nowadays, men bought a book for a few shillings, read it, put it on the shelf, and thought no more of it. Many bound volumes of newspapers were examined in the British Museum, and bindings only ten years old were found to be absolutely rotten. There was no reason why that should happen, because the British Museum authorities were not on a par with the cheap bookbinder. The leather trade had to cater for two classes, one class represented by the British Museum and large libraries who wanted and were willing to pay for a satisfactory article, and the second class represented by the British public, which loved to be deceived. It had been found that all modern leathers were short of grease. The modern hydraulic press with the pressures amounting to two or three tons robbed the skins of the very nourishment they required. But there was a limit to the amount of grease; it was as unwise to overdose a leather with grease as it was to overdose a man with drink. As he had not had an opportunity of communicating to the sub-committee the results of certain tests carried out by himself in 1892 he thonght it would be interesting if he now gave the figures. He wished to ascertain whether the use of sulphuric acid toughened or depreciated the strength of the leather. A number of pelts very carefully selected were taken, each one as near as possible of the same size, of the same substance, and of the same characteristics throughout. The first pelt was dried out and cut into little pieces of leather which were subjected to their breaking strain in a testing machine. The average breaking strain throughout the whole pelt was 130 lbs. at a 2 in. break. The next pelt was tanned by the slow process with oak bark, and broke on an average strain of 118 lbs., showing that it did not toughen the skin. The next skin was also tanned but shaved, the shaved skin being returned into tan liquors to complete the tanning and make the leather soft. That broke at 39 lbs. Another skin similarly treated but not returned to the tan liquor broke at 70 lbs., showing that the return of leather to tan liquors deteriorated its strength. The last skin was cut in two from the head to the tail. The left half was cleared in sulphuric acid and water, neutralised with salt and cut into sections, which broke at 46½ lbs. pressure. The other half was not cleared, and broke at 75 lbs., showing that the clearing of the skin for producing colours or any other purpose lessened the strength of the skin, with a consequent decrease of its wearing qualities.

Mr. DOUGLAS COCKERELL exhibited several old books and described their characteristics. The leather of one book 400 years old bound in pigskin still fulfilled its functions as a protection to the book. The calf of another book dated 1462 had become a little hard at the joints, but the leather on the sides was as good now as on the day it was put on the book. A third book bound in sheepskin, very soft to the touch, the surface of which had a tendency to rub and peel, was also in excellent condition, the joint, the leather, its colour and flexibility being excellent. The joints, back, and sides of another book, dated 1630, bound in morocco, was also in excellent condition. The specimens exhibited were not isolated instances of leather lasting so long a time, because when the committee examined libraries, old books of the 15th, 16th, and 17th centuries were constantly found in a perfectly good condition, although they were subject to all the conditions which absolutely ruined more modern bindings. He also exhibited a book with a sprinkled cover, the leather being eaten away where the sprinkle had fallen. The sprinkle in that particular instance was unduly strong, but it showed that sprinkling had a tendency to rot the leather. He had been told on remarking that the bindings of some books had gone rotten after 15 or 20 years use, that they had lasted pretty well. He thought a standard should be set up for good books of a minimum of 400 years under ordinary library conditions. In answer to Mr. R. de Coverly, who asked what guarantee there was that the bindings were as old as the books, he said that the dates could be fixed within a few years, by means of the stamps and the style of binding.

Colonel CUNNINGHAM bore out Dr. Parker's statements with regard to the effect of heat on calf and morocco-covered books. Thirty or forty years ago he bought a fairly cheap set of books bound in calf, which he took to India, where they remained for 11 years. The temperature there during at least three months in the year was seldom under 85°, and frequently 95° and 100° both day and night. The dry heat was succeeded by a damp heat of seldom less than 85°, and as high as 95°; and when he brought the books back to England, they were still in a good condition. Damp had a very deleterious effect on morocco-covered books, but did not seem to effect smooth calf. One night and a day was quite a sufficient time for the appearance of a mildew on a morocco-covered book in a damp, warm climate, and in India it was the custom to wipe books every day.

Dr. PARKER, in reply, said there could be no doubt that grease in some form preserved leather to a very great extent. Mr. de Coverly was not correct in asserting, at all events in respect to the best leathers, that the price was essential to its superiority. Bookbinders were willing to give any price, even £3 or £4 a skin, for a leather that was guaranteed to last a lifetime. Some of the cheaper class of leather was produced with remarkable skill, in many forms the practica finisher having his own recipes and "fakes," with which he produced a fine result. If the gentleman who said it was impossible to get leather free from sulphuric acid would read a previous paper read by Mr. Cockerell at the Society he would find that mention was made of three or four firms who supplied such an article. The Niger skins tested showed that they were tanned with sumach, but they bore the effects of heat, gas, and light quite as well as the best sumach skins. The guaranteeing of leather was a difficult subject, but manufacturers could easily state whether a skin had been treated with sulphuric acid, whether it was tanned with sumach, or whether it was Persian stripped and retanned with sumach. In many cases lactic acid, acetic acid, and other weak organic acids, which had not the effect upon leather that sulphuric acid had, could be used, the advantage being that they were absolutely harmless to the fibre of the leather. In reply to Mr. Birdsall, he was afraid tanners would not make sufficient money out of the process he advocated to make it profitable. With the advent of quicker methods and other tanning materials, the manufacturers allowed nearer nine days than nine months for tanning a skin. The brilliant finishes put on leather for bookbinding by the manufacturers, were useless to a large extent, because the bookbinder in using the leather wets it in order to stretch it on the book, having thus destroyed the fine finish put on by the leather manufacturer, he then refinishes the leather on the book with white of egg, or other suitable substance. It was the leather merchant, the intermediary between the manufacturer and the bookbinder, who demanded such polishes. As the bookbinder was not so particular, he thought the leather merchant might be a little less exacting. Vaseline, being a mineral grease, evaporated, and if applied to leather would have no lasting effect. If a grease of the class of lanoline were used, probably a better result would be obtained. The processes at present adopted removed the natural grease of the skin, causing it, in many cases, to decay more quickly than it otherwise would have done. In reply to the Chairman, the British Museum was examined more closely than any other library; first, because there was a larger selection of books; and, secondly, because the Museum was not lighted by artificial light, and possessed good ventilation. The results given by Mr. Seymour Jones of the breaking strain of leather were most convincing. In reply to Colonel Cunningham, it had been ascertained that dry and moist air alternately did not seem to have any serious effect on leather, this result being borne out by Colonel Cunningham's practical experience.

The CHAIRMAN, in proposing a vote of thanks to Dr. Parker, thought the British Museum, where large numbers of books were bound annually, presented a valuable opportunity for the examination of books year by year, for ascertaining whether a deterioration in the methods of binding had crept in, and in what particular year it commenced. He could confirm Colonel Cunningham's remarks respecting the effects of a moist climate on the books in India from the experience of the British Museum. When the new reading-room was built, the basements were filled with newspapers, chiefly bound in roan. The rooms were not perfectly dry, and it was soon ascertained that a mould accumulated upon the books; but the books which were not bound in roan did not suffer. When the year 1841 was mentioned he was much interested, because the system of binding in the Museum was revolutionised about that time. Up to that period, the books were bound principally in calf, but when Mr. Panizzi became keeper of the printed books in 1837, he altered the system and used morocco, which had been used ever since, and it would be interesting to know whether the books bound at the beginning of Mr. Panizzi's system in 1840-1, were better or worse than those bound about the time the deterioration was said to commence. It had been suggested that the whole mischief was caused by the intermediary between the manufacturer and the binder—the leather merchant. Was the existence of the leather merchant a necessity? Could not the manufacturer be his own merchant?

The resolution was carried unanimously.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock: –

DECEMBER 4.—"The Identification of Wood and its Application to Scientific and Commercial Purposes." By HERBERT STONE. SIR DIETRICH BRANDIS, K.C.I.E., Ph.D., F.R.S., will preside.

DECEMBER 11.—"Aluminium." By PROFESSOR ERNEST WILSON, M.Inst.E.E.

DECEMBER 18.—"Range Finders." By PROF. GEORGE FORBES, F.R.S.

Papers for meetings after Christmas:—

"The Use of Mechanical Transport for Military Purposes." By LIEUT.-COL. ROBERT E. B. CROMPTON, C.B., M.Inst.C.E., M.Inst.E.E.

"Servia as a Field for Railway, Mining, and Commercial Enterprise." By EVERARD R. CALTHROP, M.Inst.C.E., M.I.Mech.E.

"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT.

"Elliptographs." By FRANK J. GRAY, Assoc. M.Inst.C.E., F.R.Met.S.

"The Rural Schools of France." By CLOUDESLEY BRERETON.

"Recent Work on the Photography of Colour." By SIR WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S.

"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A.

"Sound Signals." By E. PRICE-EDWARDS, of The Trinity House.

"Street Architecture." By BERESFORD PITE, F.R.I.B.A.

"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY.

"The History of the Rosary in all Countries." By REV. HERBERT THURSTON, S.J.

"The use of Enamelled Tiles from an Architect's Point of View." By HALSEY RICARDO.

"London Tramways." By J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E.

"Technical Education as Applied to Paper Making." By CLAYTON BEADLE.

"Remains of the Greek Occupation of Sicily." By J. LEON WILLIAMS.

"Scientific Observations at High Altitudes." By REV. J. BACON.

INDIAN SECTION.

DECEMBER 5.—"The New Trade Route to Persia by Nushki and Seistan." By EDWARD PENTON, B.A.Oxon. The RIGHT HON. SIR HENRY DRUMMOND WOLFF, G.C.B., G.C.M.G., will preside.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at 8 o'clock:—

WILLIAM JAGO, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." Four Lectures. To be followed by practical demonstrations.

LECTURE II.—DECEMBER 2.—Flour Confectionery—Made rich by fats—Animal fats, butter, &c.—Vegetable fats—Made sweet by cane sugar, honey, malt extract.

LECTURE III.—DECEMBER 9.—Sugar Confectionery—Composition and properties of sugar; cane sugar, beet sugar, glucose, maltose—Principles of sugar boiling—Various sugar working operations—Sweets, their nutritious value. *Practical Demonstration*—Sugar working and sweet making.

LECTURE IV.—DECEMBER 16.—Confectionery—Flavoured by fruit, cherries, currants, raisins, nuts, walnuts, almonds; preserved fruits, jams, essential oils, lemon, orange, almonds; fruit essences; vanilla—Their composition and properties. *Practical Demonstration*—Piping and ornamentation of cakes.

[*The practical demonstrations are subject to alteration.*]

SAMUEL RIDEAL, D.Sc., F.I.C., "The Sterilisation of Water." Four Lectures.
January 13, 20, 27, February 3.

CYRIL DAVENPORT, "Personal Jewellery from Prehistoric Times." Three Lectures.
February 10, 17, 24.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.
March 3, 10, 17.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 2... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) William Jago, "The Chemistry of Confectioners' Materials and Processes." (Lecture II.)

East India Association, Westminster Palace Hotel, S.W., 4 p.m. Dr. David Duncan, "Is the Educational System of India a Failure?"

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. H. Alfred Roechling, "The Sewage Question during the last Century."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. R. Hedger Wallace, "Planters and Planting in Tropical Greater Britain."

British Architects, 9, Conduit-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Mr. G. A. T. Middleton, "The Story of Gothic Detail."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. W. Clayden, "The Photographic Study of Clouds."

TUESDAY, DEC. 3. Aeronautical (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. 1. Sir Hiram Maxim, "Aerial Navigation by a Body Heavier than Air." 2. Mr. William Marriott, "Atmospheric Currents." 3. Eric Stuart Bruce, "Navigable Balloons and the Scientific Aspects of M. Santos Dumont's Experiments."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Mr. John A. F Aspinall, "Train Resistance."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. G. Sinclair, "The Myriapoda collected during the 'Skeat Expedition' to the Malay Peninsula, 1899-1900." 2. Mr. W. F. Lanchester, "The Crustacea collected during the 'Skeat Expedition' to the Malay Peninsula, 1899-1900." 3. Mr. F. E. Beddard, "The Anatomy and Systematic Position of *Rhynchœa*."

WEDNESDAY, DEC. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Herbert Stone, "The Identification of Wood and its application to Scientific and Commercial Purposes."

Geological, Burlington-house, W., 8 p.m. 1. Prof. T. T. Groom, "New Genus belonging to the Leperditiæ." 2. "Sequence of the Cambrian and Associated Beds of the Malvern Hills."

Entomological, 11, Chandos-street, W., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Archæological Institution, 20, Hanover-square, W. 4p.m.

THURSDAY, DEC. 5.. SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Edward Penton, B.A., "The New Trade Route to Persia by Nushki and Seistan."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. Chapman, "The Foraminifera collected round the Funafuti Atoll from shallow and moderately deep water; with Notes on new Species from the Sands of the Reef Slope." 2. Mr. J. H. Salter, "Protoplasmic connections in the Lichens." Exhibition of Ten abnormal Sacra of the Frog, by Dr. R. G. Ridewood.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. G. T. Morgan, "Influence of Substitution on the Formation of Diazoamines and Amino-azo-compounds." 2. Messrs. A. D. Hall and E. J. Plymen, "The Determination of available Plant Food in Soils, by the use of Dilute Solvents." 3. Messrs. F. B. Power and F. Shedden, "Some New Derivatives of Gallic Adid."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon Benham, "The Literary History of the Bible."

Civil and Mechanical, St. Ermin's Hotel, Caxton-street, Westminster, 8 p.m. Mr. J. Bridges Lee, "Geometric Interpretations of Photographs."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, DEC. 6...Royal Institution, Albemarle-street, W., 9 p.m.

Civil Engineers, 25, Great George-street, S.W. 8 p.m. (Students' Meeting.) Mr. R. W. A. Brewer, "Gas Engine Construction."

Geologists' Association, University College, W.C., 8 p.m. Mr. C. W. Andrews, "Notes on a Recent Visit to Egypt."

Junior Engineers, Westminster Palace Hotel, S.W., 8 p.m. Mr. F. S. Pilling, "Street Railway Construction for Electric Traction."

Philological, University College, W.C., 8 p m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, DEC. 7...Waterworks Engineers (at the Geological Society's Rooms, Burlington-house, W.), 10½ a.m. 1. Discussion on Mr. Ingham's paper, "The Design, Construction, and Cost of Opened and Covered Service Reservoirs." 2. Reading of papers on "French, English, and American Practice in the Manufacture of Cast Iron Pipes."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, DECEMBER 6, 1901.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday afternoons, January 1 and 8, 1902, at 5 o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

LECTURE I. — Photographic Optics — Pinhole Photography—The Lens: its Defects and their Correction—Instantaneous Photography—Movements of Animals, &c.—Photography by the Electric Spark—Flying Projectiles—Falling Drops—Sound Waves—Stellar Photography—Photography and the Spectroscope—Photography of the Unseen — Photography the Hand-maid of Science.

LECTURE II. — Photographic Chemistry — The Sensitive Surface—The Negative and its Development—Photographic Printing—Photography and the Printing Press—Reproduction of Colour by Photography — Photography in Colours — Miscellaneous Applications.

The Lectures will be fully illustrated by experiments, photographs and lantern slides.

Members who desire tickets for the course are requested to apply for them at once.

Each member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received.

CANTOR LECTURES.

Mr. WILLIAM JAGO, F.C.S., delivered the second lecture of his course on "The Chemistry of Confectioners' Materials and Processes," on Monday evening, 2nd inst.

The lectures will be published in the *Journal* during the Christmas recess.

NEXT WEEK.

MONDAY, DECEMBER 9, 8 p.m. (Cantor Lecture) — WILLIAM JAGO, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." (Lecture III.)

WEDNESDAY, DECEMBER 11, 8 p.m. (Ordinary Meeting)—Prof. ERNEST WILSON, M.Inst. E.E., "Aluminium."

Further details of the Society's meetings will be found at the end of this number.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 4th, 1901; Sir DIETRICH BRANDIS, K.C.I.E., Ph.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

De Friese, Lafayette H., Broad-street-house, Old Broad-street, E.C., and 32, Liberty-street, New York, U.S.A.
Gibson, Robert, Limerick, Ireland.
Kendal, James Francis, 440, Camden-road, N.
Leer, Isaac Wayne von, Hotel Sanz, City of Mexico, Mexico.
Uhler, Philip Reese, LL.D., The Peabody Institute, Baltimore, Maryland, U.S.A.

The following members were balloted for, and duly elected members of the Society:—

Aiyangar, K. Srinivasa, Assistant Engineer, P.W.D., Camp Gudwada, Madras, India.
Aiyengar, N. S. Bashyam, Little Conjeeveram, Madras, India.
Armitage, Frederick, 88, Amhurst-park, Stamford-hill, N., and Monument-station-buildings, King William-street, E.C.
Armstrong, Frank, 88 and 90, Deansgate, Manchester.
Ashton, James, Hacken Sewage Works, Moses-gate, Bolton.
Ashworth, John Jackson, Haslen-house, Handforth, Cheshire, and Faulkner-street, Manchester.
Atkinson, George, 43, Cleveland-road, Crumpsall, Manchester.
Bailey, Harry Dorning, 16, Fenchurch-street, E.C., and Sale-hall, Sale, Cheshire.
Bana, R. H., Navsari, near Surat, India.
Bankart, George B., Bromsgrove, Worcestershire.
Barker, Henry E., Accra, Gold Coast Colony, West Africa.
Barnard, Robert, Bhalgora-house, Jharia, Bengal, India.
Barralet, Edgar Stuart, 2, Green-street, Bethnal-green, E.

Barwell, Noel F., 3, Russell-chambers, Bury-street, W.C.
Bennett, Thomas Jewell, care of James Douglas, Bangor, North Wales.
Berg, H., B.Sc., Telegraph Works, Silvertown, E.
Bhargava, Prag Narain, Newul Kishore Press, Lucknow, India.
Bill, John Hugo Hepburn, Multan, Punjab, India.
Bingham, Herbert, Drayton-street, Leichhardt, Sydney, New South Wales, Australia.
Breckinridge, Cabell, Danville, Kentucky, U.S.A.
Broome, Joseph, Bayonne, New Jersey, U.S.A.
Brown, James, Park-lodge, Rawal Pindi, India.
Burgess, Alfred, The Motor Manufacturing Co., 47, Holborn-viaduct, E.C.
Calvert, Richard, J.P., Walton-house, Walton-le-Dale, near Preston.
Campos Novaes, Dr. José de, Estacao da Capoeira Grande, Ramal Ferreo Campineiro, Estado de Sao Paulo, Campinas, Brazil, South America.
Carter, Captain John Robert Blackall Graham, I.S.C., Songad, Kathiawar, Bombay, India.
Carter, Owen, Wykeham, Poole.
Chalmers, William James, 1428, Marquette-building, Chicago, U.S.A.
Chatterjee, Abinash Chandra, B.A., 12-3 and 12-4, Pataldanga-street, Calcutta, India.
Chesterman, William, Belmayne, Sheffield.
Chivers, Cedric, Portway, Bath.
Clyburn, William Douglas, Baghitand, Koderma, Hazaribagh, Bengal, India.
Cooch-Behar, His Highness the Maharajah Bhup Bahadur of, G.C.I.E., C.B., Darjeeling, India.
Cook, William Henry, Cotham-house, West-hill, Huddersfield.
Cooper, William, 1, Bonnington-terrace, Edinburgh.
Crombie, Charles H., B.A., West-gate, Burford-road, Whalley-range, Manchester.
Crook, W. E. Froome, 64, Thornfield-road, Uxbridge-road, W.
Dalam, Hon. Dato Bintara, S.P.M.J. (Ibrahim bin Abdullah), Johore Bahru, Johore.
Dattari, Giovanni, Sharia Kasr el Nil, Cairo, Egypt.
De la Plaza, Dr. Victorino, 13, Park-place, St. James's, S.W.
Deneke, Moritz, 12, Tokenhouse-yard, E.C.
Denny, John T., 42, Devonport-road, W.
Dewsnup, Ernest Ritson, M.A., Technical College, Huddersfield.
Drummond, James Ramsay, B.A., F.L.S., Gurdaspur, Punjab, India, and care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.
Duncan, Robert, Maarama-crescent, Wellington, New Zealand.
Dutt, B. A., B.A., Katmandu, Nepal, India.
Eastlake, Charles L., J.P., Long Sutton-house, near Langport, R.S.O., Somerset.
Emtage, Raymond Howard, 14, James-street, Bridgetown, Barbados, British West Indies.
Fakhruddin, H. H. M., Halsey-road, Cawnpore, India.
Flanagan, Henry George, Prospect Farm, Komgha, Cape Colony, South Africa.
Foot, Lionel Rayne, Coleman-house, Cape Coast Castle, Gold Coast, West Africa.
Forster, John Walter, 18, Mountfield-gardens, Tunbridge Wells, Kent.
Fosbery, Widenham Francis Widenham, 2, Bute-road, Wallington, Surrey.
Fox, Frederick J., 49, Farquhar-road, Upper Norwood, S.E.
Fraser, James, 12, William-street, Forebank, Dundee.
Gardner, Ernest, M.P., Spencer Farm, Maidenhead, Berks.
Ghose, Dr. Ashutosh, L.M.S., 89, Beadon-street, Calcutta, India.
Gibb, James, Khas Jharia Colliery, Jharia P.O. Bengal, India.
Godwin, J., Assistant Engineer, P.W. Dept., Jammu and Kashmir State, Punjab, India.
Green, Henry Edward Owen, J.P., Bulawayo, Rhodesia, South Africa.
Hall, William Brasier, Engineer-in-Chief's Department, Admiralty, Whitehall, S.W.
Halton-Stone, H., Fostals, Margate-road, Herne Bay.
Harris, Wilfred M., Endcliff, Kendal.
Hay, Major Arthur E., United Service Club, Pall Mall, S.W.
Heinze, F. Aug., The Montana Ore Purchasing Co., Butte, Montana, U.S.A.
Herreshoff, Nathaniel Greene, Bristol, Rhode Island, U.S.A.
Hodge, Francis, Coromandel, near Auckland, New Zealand.
Hook, Major David Blair, Herschel, Cape Colony, South Africa.
Horn, Alexander, Messrs. Clarke, Nickolls and Coombs, Limited, Hackney-wick, N.E.
Hornby-Porter, Charles, Lagos, West Africa.
Houghton, Thomas Marcus, 15 Montholme-road, Wandsworth-common, S.W.
Husain, Shaikh Mohammed, Khan Bahadur, H.B.M. Vice-Consul, Jeddah, Arabia.
Johnson, Professor John Butler, University of Wisconsin, Madison, Wisconsin, U.S.A.
Johnston, John Williamson, 46, Leadenhall-st., E.C.
Jones, Frederick John, Treeton-grange, Rotherham.
Just, John Augustus, 116, W. Castle, Syracuse, New York, U.S.A.
Kay, Arthur, Winton Drive, Glasgow.
Keen, Arthur, Sandyford, Edgbaston, Birmingham.
Kelf, Henry Charles, care of Messrs. Parry and Co., Nellikuppam, South Arcot, India.
Khunnah, Juggernauth, Messrs. J. Khunnah and Son, Calcutta, India.
Kidstone, George J., Finlaystone, Langbank, Renfrewshire, N.B.
King, Arthur William Waterlow, Orchard-house, 2 and 4, Great Smith-street, S.W.
Kirby, Frank E., Detroit Shipbuilding Co., Detroit, Michigan, U.S.A.

Knox, G. Walter, B.Sc., 16, Finsbury-circus, E.C.

Kwong Yung Kwang, The Chinese Engineering and Mining Co., Linsi Colliery, Tientsin, North China.

Lawes, Sir Charles Bennet, Bart., The Studio, Chelsea-gardens, S.W.

Leonard, Arthur G., Divisional Commissioner for Southern Nigeria, W. Africa.

Lewes, Charles Llewellyn, 12, Old-square, Lincoln's-inn, W.C.

Lewis, E. J., Frant Field, Eden-bridge, Kent.

Little, Edwin, Fleet Engineer R.N., H.M.S. *Empress of India*, Mediterranean Squadron.

Little, Ernest John, Brentwood-road, Romford.

Löfgren, Alberto, F.L.S., Director do Horto Botanico, Sao Paulo, Brazil, South America.

McDonald, Alex., 171, King's-road, Chelsea, S.W.

MacDonald, S. Fremont, The Ashtabula Hide and Leather Co., Ashtabula, Ohio, U.S.A.

Mackenzie, Thomas B., 342, Duke-street, Glasgow.

Mallik, Ramani Mohan, Meherpore, Nuddea, Bengal, India.

Manning, Arthur Hope, J.P., P.O. Box 88, Heidelberg, Transvaal Colony, South Africa.

Mardon, Evelyn John, B.A., LL.B., Etawah, N.W. Provinces, India.

Martin, R. Banks, 121, Plashet-grove, East Ham, E.

Mathieson, George, Messrs. Clarke, Nickolls and Coombs, Limited, Hackney-wick, N.E.

Mawson, Ernest Oscar, Rajkote, Kathiawar, Bombay, India.

Mercer, Thomas, 14, Prospect-road, St. Albans, Herts.

Meyer, Alexander, Royal Palace Hotel, Kensington, W.

Miller, James William, M.A., 2, Hastings-terrace, Sandycove, Co. Dublin.

Mir Muzheruddin, Sahib, Madras, India.

Mobsby, G., 13, Chaoufoong-road, Shanghai, China.

Monington, Harold Warren, 4, Finsbury-circus, E.C., and 19, Gayville-road, Nightingale-lane, Wandsworth-common, S.W.

Moore, Richard Francis, Hillside, 72, Amhurst-park, Stamford-hill, N.

Morris, Thomas Morgan, 12, Green-street, Neath.

Morse, Edward S., Ph.D., Museum of Fine Arts, Boston, Mass, U.S.A.

Morse, Willard S., American Smelting and Refining Co., Aguascalientes, Mexico.

Muter, Captain R. S., R.E., Yacht Club-chambers, Bombay, India.

Naidu, C. Tirumalayya, Ganasrama, Triplicane, Madras, India.

Neel, Edmund, C.I.E., 17, Ladbroke-square, W.

Nettlefold, Godfrey, Hallfield, Edgbaston, Birmingham.

Nowell, Arthur Berry, Cherra Punjee, Khasi Hills, Assam, India.

Oman, John Campbell, 26, Tollington-place, Finsbury-park, N.

Osgood, Joseph Otis, Plainfield, New Jersey, U.S.A.

Ouseley, Joseph William Glynn, Herbertpore, Dehra Dun, N.W.P., India.

Palmer, Henry Boswell, 13, Chapter-road, Willesden-green, N.W.

Pantalu, Jayanti Ramayya, B.A., B.L., Deputy Collector, Kistna, Madras, India.

Parker, John Falkingbridge, 18, Coleman-street, E.C.

Parsonage, William Rawlett, Cleevedale, Birchwood-crescent, Sparkbrook, Birmingham.

Peeke, George, Neckinger Mills, Bermondsey, S.E., and Hillside, Marischal-road, Lee, Kent.

Phillips, Henry Druit, 48, Russell-square, W.C.

Pimpalkhare, S. K., Shukrawar No. 1, Poona City, India.

Poole, Frederick Jesse Cooper, Municipal Technical Schools, Southend-on-Sea.

Pope, George, 230 and 231, Sherlock-building, Third and Oak-streets, Portland, Oregon, U.S.A.

Potter, Thomas Irwin, Brighton-pier, La Brea, Trinidad, British West Indies.

Powell, Sidney John, 7, Allison-grove, Dulwich-common, S.E.

Ram, Lala Sita, Ballia, N.W. Provinces, India.

Rand, Richard Frank, M.D., F.R.C.S., Sterndale, Royston-park, Hatch-end, Middlesex.

Rea, Alexander, Superintendent of the Government Archæological Survey, Bangalore, Madras, India.

Rickie, Robert, Bangalore Ironworks, Bangalore, India.

Robeson, Anthony Maurice, care of Messrs. Wernher Beit and Co., 120, Bishopsgate-street Within, E.C.

Rodocanachi, Emmanuel Michel, M.A., 66, Westbourne-terrace, Hyde-park, W.

Rose, Charles Day, Hardwick-house, Pangbourne.

Saing, Hon. Hkun, C.I.E. (Sawbwa of Hsipaw), Hsipaw, Northern Shan States, Burma.

Samarth, Dewan Bahadur V. M., care of Messrs. William Hutchinson and Co., 2, Trafalgar-buildings, Charing-cross, S.W.

Scott, Charles Victor George, B.A., B.A.I., Public Works Department, Lyallpore, Punjab, India.

Scott, James, 151, Strand, W.C.

Settle, Joseph Burton, 4, Coleman-street, E.C.

Shepheard-Walwyn, Hugh Wallwyn, M.A., Dalwhinnie, Kenley, Surrey.

Sim, Henry Alexander, C.I.E., Somerford, Adyar, Madras, India.

Simmons, E., Rosa, N.W. Provinces, India.

Sims, Joseph Charles, Witney, Oxon.

Stanford, Edward Charles, 191, Friern-road, Dulwich, S.E.

Steele, W. R., care of Messrs. Burn and Co., Howrah, Bengal, India.

Stow, John Freebairn, Council Offices, Uxbridge.

Sully, F. Harold, 18, Trebovir-road, Earl's-court, S.W.

Tilly, Harry Lindsay, Rangoon, Burma.

Tonge, James, jun., 149, Church-street, Westhoughton, Lancashire.

Trevaillé-Williams, Thomas, the Johannesburg Consolidated Investment Co., Johannesburg, Transvaal Colony, South Africa.
Turner, Fred., 124, Womerah-avenue, Darlinghurst, Sydney, New South Wales, Australia.
Tweddill, Samuel Milbourn, Museum Geological Survey, Pretoria, Transvaal Colony, South Africa.
Waldram, Robert Edward, 14, Vernham-road, Plumstead.
Waller, William, Vauxhall-walk, S.E.
Weir, James W., J.P., King William's Town, Cape Colony, South Africa.
Wellington, Stephen Newcombe, Mindon-villa, Colpetty-road, Colombo, Ceylon.
Wherly, Silvester Stevenson, Cheviot-villa, Benton, and 14, Neville street, Newcastle-on-Tyne.
White, Charles Arthur, Executive Engineer, P.W.D., Midnapore, Bengal, India.
Whitehead, James, Lindfield, Fulsham-park, Wilmslow, Cheshire.
Whitla, Colonel William, Naval and Military Club, 94, Piccadilly, W.
Willey, Henry Alfred, 3, Pennsylvania-park, Exeter.
Williams, W. Nance, 18 Randolph-crescent, Maida-vale, W.
Wilson, Archibald Laurence, Ravenswood, Queensland, Australia.
Wingate, Major Alfred Wodrow Stanley, I.S.C., Intelligence Branch, Headquarters Staff, B.C.C.F.F., Tientsin, China.
Wintle, William James, 18 Vincent square, Westminster, S.W.
Woolnough, Cornelius, 17, Harold-street, Loughborough-road, Brixton, S.W.
Yerbury, John E., The Settlement, Tavistock-place, W.C.
Zafar Jung Shumsud Dowlah, His Excellency Nawab (Shumsul Mulk Bahadur), Hyderabad, Deccan, India
Zambra, Julius James George, 18, Thurlow-road, Hampstead, N.W.

The paper read was—

THE IDENTIFICATION OF WOOD.

By Herbert Stone.

The subject upon which I have the honour of addressing you to-night is incomplete, and, as yet, quite in its infancy. As a scientific study it is by no means new, but the technical application of it may be said to be comparatively recent, as might be expected, because a certain amount of progress must be made, and sufficient methodically-arranged information must be accumulated before the commercial man can employ it usefully. In short, until science has something substantial to offer, which will stand the commercial test, it is far better to continue the use of the old rule of thumb methods, which, after all, have sufficed to make the world go round till now. Whether the art of discriminating the various species of timber has arrived at that desirable stage I must leave it to your judgment to decide, but I feel that a ventilation of the subject must be productive of good, and hope that it will arouse sufficient interest to bring recruits to this inquiry. It is a field in which the greater part of the ground is unbroken, and when nearly all other subjects have been thoroughly worked, it is something especially gratifying to an investigator to find himself in the midst of a practically unexplored area. The nearest comparison I can think of would be the case of a man set to classify the specimens of a herbarium, from which all the flowers had been removed. The material would be sufficient for the purpose, the schemes of classification would be at his disposal, but he would be compelled to invent for himself the means of discovering the relationship of his plants one to another. I may say that there is nothing extravagant about this simile, for Radlkofer and the botanists of his school, chiefly Dr. Hans Solereder, have worked out a system by which small and imperfect specimens of plants may be recognised and classified, and in some respects have made discoveries which materially aid us in the discrimination of timber. Unfortunately for us, this school of Radlkofer has confined itself to the examination of such small twigs and woody stems as are usually found along with herbarium specimens, and as the secondary wood, or that produced after the first year, frequently differs from the primary wood, which is their special care, their labours are only useful by-the-way, and in rare cases.

The chief contributions to the branch of botany have been made by students of forestry, and as forestry is little known and appreciated in England, it is to Germany that we must look for information. The two Hartigs and Franz Schwartz have dealt with the European trees in a fairly complete manner, and Mayr has made some important contributions to the anatomical characters of the conifers of North America, but foremost stands Nördlinger, who has described the structure of no less than 1,100 species of timber trees, and whose series of sections is the wonder and admiration of the few who have seen them.

J. S. Gamble's "Indian Timbers" is a fine work, and the only one which is published in the English language (saving a translation of a small *brochure* by Theo. Hartig). His collaborator, Sir Dietrich Brandis, who did the descriptive work for "Indian Timbers," is perhaps the chief living authority on the subject. A magnificent series of 200 sections of American woods, published by Romeyn B. Hough in the United States of America, is another substantial aid; but unfortunately, his descriptions accompanying the sections show that the author is unaware of the significance and value of his own specimens.

In all these books there is nothing approaching a scheme of classification. The nearest is contained in the notes accompanying the descriptions in J. S. Gamble's "Indian Timbers," but as they are based exclusively on the local species, they are quite useless when applied to timbers of other countries. All other authors confine themselves to isolated descriptions of species, with an artificial key as a guide amongst chaos.

We can now see what our future labour is, and I must content myself with indicating it, merely repeating that the harvest is ready for any one who will lend his assistance.

In the meantime there is no necessity to underrate the value of the old time-honoured rule of thumb method, and we shall do well to hold to everything that is good in it, and to add such precise knowledge as can be accumulated. Heretofore, everything was left to individual judgment, which implies great experience, needing time and opportunity to acquire. Learners had no easy task before them and no aid, except that of teachers; still it sufficed until foreign timbers began to be imported in increasing variety, which, in proportion, restricted the possession of expert knowledge to the few. The carpenter knows the woods he works with from continually handling them, and can, perhaps, distinguish a dozen or twenty of them with ease. Beyond these he is at sea. The timber merchant dealing in hardwoods has a longer list of familiar woods, and having spent his days amongst them he becomes an authority upon them. But the process of handing a strange piece of wood round until someone is found who knows it, is a part of the daily routine even at the oldest houses. When, as often happens, a species not previously met with turns up, even the most expert are helpless, and I think they will be the first to admit that some means which will eke out their experience is desirable. I have met with cases where a wood well known and largely imported has been pronounced by various timber merchants to be something quite different, and others in which inferior woods have been palmed off upon purchasers when their superficial resemblance to the superior article has been close enough to deceive. I have also known a case where an inferior wood, selling at a low price, has obtained a much higher one by the simple expedient of changing the name to B when it has been previously known as A. Without dwelling on these doubtful practices, which are exceptional, more than to lay stress on the fact that the lack of information makes them possible, I will turn to another class of cases, those in which a consumer desires to match an unknown wood, or having tried a parcel with success, is unable to obtain a second for the reason that he does not know for what to ask.

Many hundreds of consignments of excellent timber reach our shores, and failing sufficient information as to their name, origin and virtues, are passed by purchasers until they are finally relegated to a rummage sale, where all "unrated" timber is put up to auction for the purpose of recovering the freight and dock dues. Amongst these "unrated" woods, have been many which have excited admiration for their beauty or other excellence, and in some cases have changed hands after the discovery of their value at fancy prices. But when the parcel is sold out, the trade in these woods is closed, for the unfortunate sender of them is careful not to risk another loss on the same timber, thus no more comes forward, and as the consumer has no means of finding out the name and place of origin of the coveted wood, he has no opportunity of making his wants known to the person who could satisfy them. From what I have seen myself, I feel certain that there are many species of timber trees growing, may-be in abundance, in many localities from which shipment might be made, that are ignored because they bear a reputation of being unremunerative, and are probably put locally to base uses.

If you will look through any old list of hardwoods you will see the names of many that were familiar years ago, but which are not now met with. Did the consumption of the timber trade of the last generation exterminate these trees? I cannot believe it, for even if a small locality were entirely stripped of a species, there are few that are confined to such small areas. Possibly if they grow elsewhere we may by some good chance hear of our old friends again when other forests are opened up, and I hope that with the increasing means of identification which the anatomical characters afford, we may not only discover the species, but also indicate in what other regions a fresh supply of our lost timbers may be found.

I was recently amused by receiving a circular from a hardwood merchant, containing a long list of uncommon woods. I wrote asking for specimens, and was informed that though anxious to oblige, the merchant could not send them, as most of the woods enumerated had not been met with for years. The old list had evidently been reprinted from time to time, in the hope of supplies turning up.

There are instances already on record where the anatomical characters have been commercially useful, and unknown woods identified by their means have lead to inquiries in a proper direction being made for fresh supplies, but this can only be done when the structure is put upon record in such a fashion as to be traceable when needed, a state of things which does not yet exist. The cases in point were the result of a happy recollection of the special structure and not of method. It is also necessary that the scientific name should accompany the description of the structure. If the popular or vernacular names only are known, we really are not much further ahead because there is usually a name in every locality and sometimes several.

To base this art upon a secure foundation, it is absolutely necessary to obtain authenticated specimens. One may describe the structure of the African oak, and it may be an advantage to identify other specimens of African oak from the description, but it will be useless for a purchaser to inquire for it under that name in localities where it is called African teak. If we only knew the specific name we could point out fresh localities where any botanical explorer may have recorded its occurance.

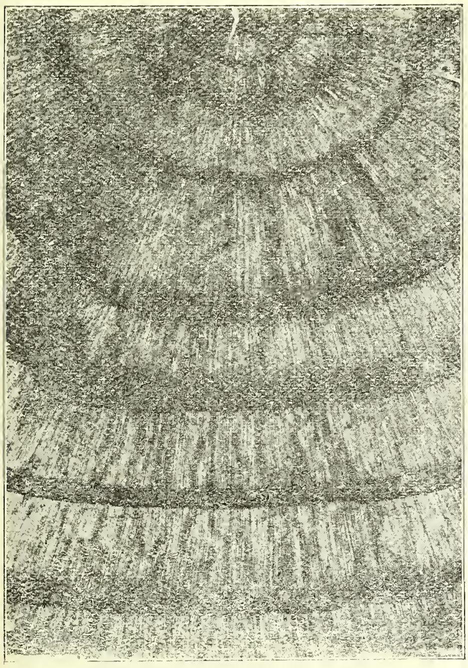
By-the-way botanical explorers have a vexing way of omitting anything likely to be useful from their descriptions of plants. They describe the flower, leaves, and habit with great precision; and I have known, as a rare case, a botanist to mention that a plant produces the fibre, gum, drug, or whatnot of commerce, but he gives no indication whatever of the special features by which the fibre, gum, or drug may be recognised. This is lost opportunity, for the information must have been in many cases within reach, and would have been precious, but as it is we must begin again at the beginning, make our own explorations, and in fact conduct a duplicate survey over precisely the same ground, with a but slightly different object. With this view I have appealed to the Colonial Office for authenticated specimens of all Colonial timbers, with a view of putting their structure on record, and enabling not only our home traders to recognise unfamiliar Colonial timbers when they meet with them here, and to satisfy their wants by purchases from our brethren of Greater Britain, to the benefit of each other, but also to enable our colonists to recognise their own woods for their own uses. If experts are scarce in England, they must be far rarer in new countries. Besides this, our settlers had a limited knowledge of English trees when they left our shores, consisting of a few names, such as oak, beech, ash, elm, pine, &c., and every tree they met with in their new home became native oak, native beech, &c., with the variation of a few simple adjectives, such as red ash or black ash. When these become exhausted, the alternatives are red wood, white wood, yellow wood, iron wood, and the like, hence we must not be astonished to find that in different parts of Australia, no less than five distinct species of eucalyptus pass under the name of Red Gum, and two or more under that of Blue Gum.

I am fortunate in being able to make my appeal at a time when the office of Colonial Secretary is filled by a man whose foresight and acumen are as keen as his care for the interests of the Colonies is enthusiastic. In short, by his kind recommendation of my petition to the various Colonial Governments, I have already obtained promises of authenticated specimens of the woods of Canada, the Cape of Good Hope, Victoria, Queensland, Western Australia, Lagos and Rhodesia, and, with one or two exceptions, I have very little doubt that a similar response will be received from those Governments which have not yet replied. In my petition I have asked for a specimen of each wood sufficiently large to provide duplicates for several public institutions.

However complete the knowledge of the Colonial timbers may become in the course of the next few years, it will be a mere fraction compared with the work that will remain, and which will be left to travellers who may be persuaded to take note of the timbers as well as the flowers they meet with. Perhaps if the scientific side of our study can be developed sufficiently to attract the attention of botanical explorers, we may achieve our end by their assistance.

So far the work of Solereder and others has aroused very little enthusiasm, and it has been stated that the value of the anatomical characters for the purpose of classification is trifling. With this I am inclined to agree in part, because so much stress has been laid upon the sculpture of the walls of the individual cells, failing more prominent characters. It is, no doubt, a valuable contribution to our knowledge to know that certain forms of pits are constant in a Natural Order, but if, as usually happens, they are equally constant in a score of little related orders, they afford little help in separating one from another. The primary wood dealt with by the school of Radlkofer, is not enough by itself, the material is too sparing and it holds the same position in lignology as animal embryology does to anatomy. It is the study of an immature condition only. Besides this their descriptions are lacking in vividness.

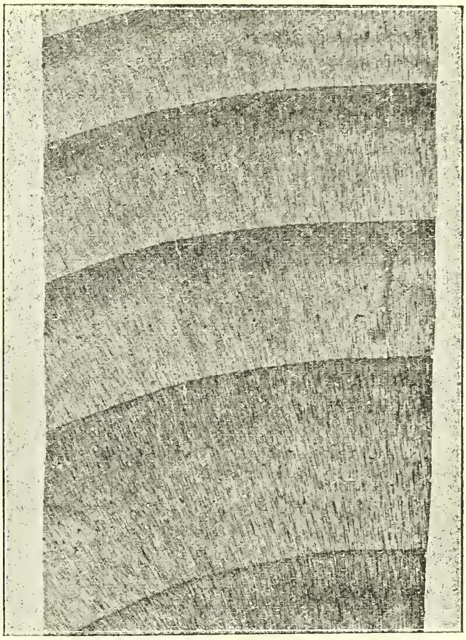
Fig. 1.



Fir: A Conifer without Resin-pores. Transverse section × 3½.

As a matter of fact, the diagnosis of the characters of wood depends very greatly upon precision of language, and this again upon a knowledge of the infinite variety of form which may be presented by the pores, rays, and soft tissue. It must be clearly understood that the width of the annual rings, the most conspicuous feature, is rarely of any value, and I shall be glad if, when looking at the specimens I am about to shew you, that you will endeavour to ignore this factor altogether. A ring of oak wood may be $\frac{1}{10}$th of an inch wide, or may reach $\frac{5}{8}$ths, and the difference in the appearance of a piece of wood containing 16 rings per inch of radius and another only showing two is exceedingly difficult to reconcile. This variation is merely a question of growth, and depends upon the fertility of the soil, &c., so that the extremes may frequently be present in the same piece of wood in the closest proximity. This much may be said that the annual ring usually makes a good start in the spring, when the tree puts forth its leaves, so that the innermost layer is usually normal, but should the supply of nourishment fail from any cause such as the destruction of the foliage by frost or caterpillars, the later wood of summer and autumn may be reduced even to disappearing. The full character of the structure is unfortunately only brought out in broad well-developed rings, and it is by no means rare to find a specimen with which nothing can be done, because no ring is broad enough to shew the structure of the autumn wood. Search then always for the broadest ring.

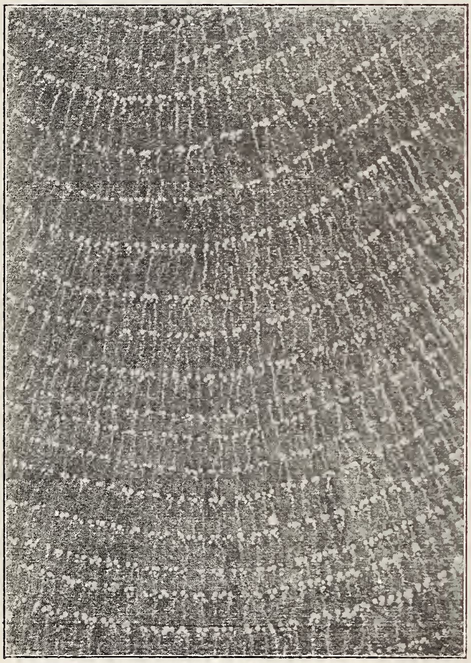
Fig. 2.



Pine: A Conifer with Resin-pores. Transverse section × 3½.

The chief point then to be noticed is the presence of absence or true pores which may be recognised by their abundance in the inner side of the ring. They are never more abundant in the autumn wood, even when uniformly occupying the whole section. If pores appear in the outer or middle part of the ring while the inner is free from them, be sure that they are resin pores, and that the wood you are dealing with is a conifer, and probably a pine or spruce. The rays are always present, even when microscopic, but they vary greatly in breadth, height, lustre, straightness, &c., each detail having its own particular value. The specimen of oak you have in your hands has extremely broad rays which are lustrous and of considerable height on a tangential section, but in the transparent section of maple attached to the little cards, they are only just visible to the naked eye. Even these are broad comparatively to those of the horse chesnut and many conifers. As a rule, the narrower the rays in a transverse section, the shorter or shallower they are in other sections—that is, the proportion of breadth to depth is remarkably constant.

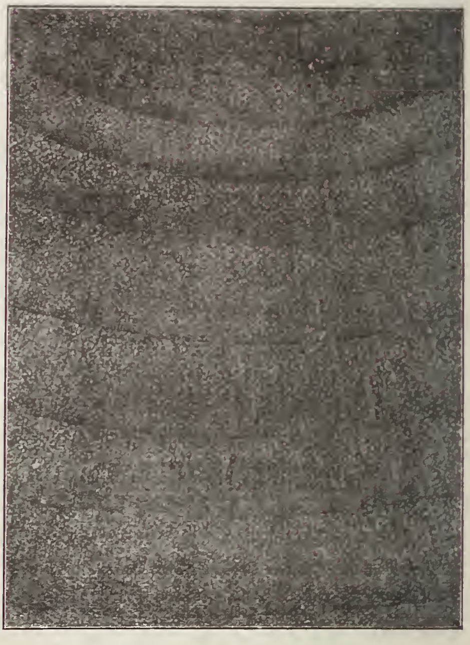
FIG. 3.



OAK.—Transverse section × $3\frac{1}{2}$.

The year's growth of wood is well indicated in each ring of both oak and maple, but in quite different fashion; the former has bold pore-rings of one or more rows, following on the somewhat pore-less autumn wood of the previous year, whereas the latter has a very fine, perfectly distinct line of autumn wood, and the pores, instead of rapidly diminishing outwards almost to vanishing point, and assuming a tree-like form, are of uniform size and somewhat sparingly scattered over the small areas formed by the regular cutting of the annual rings by the rays. A close examination of the small oaken block will reveal a number of cloudy bands running concentrically with the annual rings. These are composed of wood parenchyma, or soft tissue as I shall call it, and are usually present in well-developed rings in all the oaks. The two examples I have selected, belong to two distinct types. I choose them as being particularly suitable for the purpose of showing the very different forms the various parts of the wood can assume, but they are only two amongst hundreds of types, for the arrangement of the four elements, the rays, the pores, the annual rings, and the soft tissue, is almost infinitely varied.

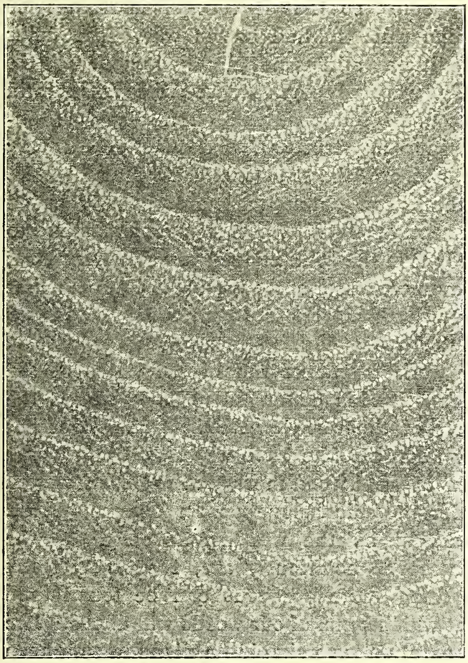
FIG. 4.



MAPLE.—Transverse section × $3\frac{1}{2}$.

One of the difficulties of this study is the unending fluctuation of the size in the various parts, which is the outcome of the influence of age, soil, and climate, that is to say, of the vigour of growth. The variation which most meets the eye, that of the annual rings, has already been referred to. Next to this the coarseness of the pores chiefly affects the appearance of a wood. This depends more upon age than upon nourishment, and in many woods, such as the oak, the average size of the pores augments from year to year till the tree reaches its prime, and then becomes more or less constant. Other woods shew their variation in a much less degree. This makes accurate measurement difficult, in fact a statement that the average diameter of the pores of the oak is a certain fraction of a millimetre is really useless as a guide, therefore Nördlinger, and after him Brandis and Gamble, adopted the method of using a series of well-known woods and employing them as standards with which to compare others; each type thus shews its own limits, and the measuring process becomes an estimate of the range of fluctuation in size. This is a simpler process than it seems, and in practice all that is necessary is to have a set of thin sections or shavings between two pieces of thin glass, which may be laid upon the section or even the solid wood of another specimen, and the size of the pores, &c., as ascertained by direct comparison. In all cases where the structure of a wood has to be described in words, the largest pores or rays in each ring are only regarded, and the size is expressed by figures which indicate the minimum and maximum size of these largest elements only, as found in rings of varying age. The reason of this is obvious. The pores are found to diminish in every ring, sometimes only a little, as in the maple, but more frequently to vanishing point as in the oak.

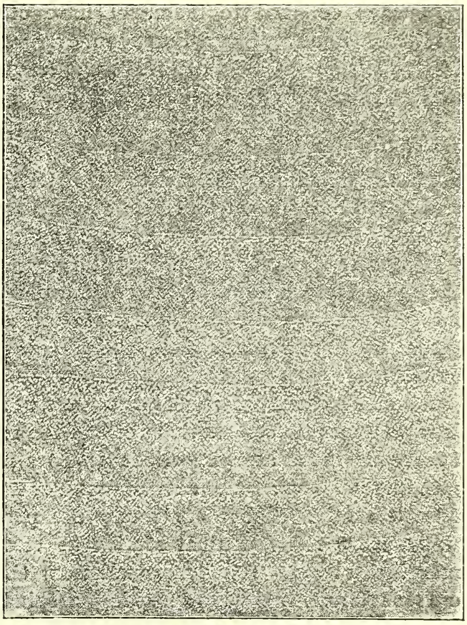
Fig. 5.



Common Elm.—Transverse section × 3½.

There is considerable harmony in the variation of the characters of wood, both physical and anatomical. The weight per cubic foot, the hardness, the state of saturation, amount of ash, the elasticity, &c., vary regularly, according to age and distance from the root of the tree. Weight is found to increase from the foot to the first branches, and then to decrease from that point upwards. The size of the rays, cells, and vessels, as already stated, increases with age, so that in the 80th yearly ring of an oak, counting from the pith outwards, these parts will be much larger than in the first. It must be borne in mind that the 80th ring was produced 79 years later than the first, so that we must be careful not to confound the age of the tree with the age of its wood.

Fig. 6.



Willow.—Transverse section × 3½.

Similarly, inasmuch as the sapling oak of one year is but a fractional part of the weight of the mature tree, and as the growth in height has been caused by the super-position of additional coats of wood one upon another, like so many cones, it follows that the wood of the upper parts must be younger, and therefore the innermost ring of this upper wood must not be assumed to be old because of its position. It is natural to assume this, and many would count the rings on a piece of wood from the upper part of a trunk, and pronounce it to be of such and such an age, whereas that may not be within fifty years of the truth.

Many tropical woods show scarcely any perceptible division between the growth of one year and the next. Their growth seems free from any check, though it may vary in vigour. Hence the familiar ring-boundaries become vague or entirely lost ; even the rise and fall in the size of the pores is frequently absent, and they seem to increase uninterruptedly from the pith outwards to the bark. This state of things is found in quite a number of unrelated tropical South American woods, though it is by no means confined to them. I have often wondered if any of our European evergreen trees, such as the holm oak (*Quercus Ilex*), if acclimatised in a tropical region, would lose their characteristic rings, and take upon themselves this uniform structure of wood. No doubt the climate would modify it somewhat, and it has been urged that this circumstance vitiates the value of the anatomical characters for purposes of classification. True ! as regards the succession and dimensions of each zone or its component parts, but their structure and arrangement remain the same, and will always stand good.

In many natural orders, the soft tissue which is so prominent in concentric circles in the oak, affords us great assistance. It appears in a multitude of forms, and may be found in little narrow circles or borders round the pores, which show on a vertical section as cloudy margins to them. It may expand from these circles laterally into wings forming a spindle-shaped patch, in the midst of which the pore may be embedded. These wings may widen until they meet others, and join up to form circles concentric with the rings, straggling oblique lines, or long undulating wreaths. The lines may become narrowed to microscopical fineness, making a mere network with the rays, or may be broad conspicuous bands. In fact, from mere ill-defined scraps the soft tissue can vary to elaborate tracery. It is somehow or other closely connected with the natural affinity or relationship of woods, and more often than any other character helps us to guess at the place of a species in the natural system, but (there is invariably a "but" in connection with these details) it is not rarely absent in a genus or species, where one would most expect it. Gamble relies upon this feature in his artificial classification of the Leguminosæ, and it works beautifully within the limits of the Indian species, but it fails entirely where a larger range of leguminous plants is taken, especially in respect to those of temperate climates. He relies especially upon the width of the bands of soft tissue, but in applying it, I have so often met with intermediate gradations of breadth, that I am forced to conclude that its use in this order must be restricted to small groups of species only. The extremely fine bars which may be seen crossing the rays in the ebonies, and the somewhat different bars characteristic of the lancewoods and many others, hold good over large numbers of species, so that it becomes a matter for investigation to find out in which particular form it may or may not be relied upon.

The vertical sections, *i.e.*, the radial and tangential sections, will often elucidate obscurities of structure, and give one a very clear idea of the structure of wood as a whole. I think one obtains a more securely based conception of what wood is by commencing to study it in the solid instead of by macerations, or even thin sections. To study the cells first under high powers is, to my mind, beginning at the wrong end. The microscopic part of the work is one of the higher walks of the science, and is better led up to by way of the study of the wood *en bloc*. I have met but few botanists who have anything but a vague idea of what wood in general is, when viewed under the microscope as an opaque object. Beautiful as the wonders revealed by the microscope notoriously are, I scarcely think anything more gorgeous can be found than that which some of our woods will afford. The preparation is so simple—a plane, with a keen iron, or even a sharp pocket-knife, is all that is required, and a smooth and clean-cut surface will not only show you an unexpected play of colour, but will demonstrate the relation of cell to vessel, and vessel to ray, in a manner impossible in a thin section in which one endeavours to separate the desired layer from all the deeper-seated tissue. Wood is much more transparent than one would think, and the subjacent cells appear distinctly below those immediately on the surface, therefore the relations of each cell in every direction become evident. These shew every variation of amber, ruby, gold, rich browns and black and bright translucent beads of resin, which flash in the light like jewels that tempt one to forget one's work for the indulgence of the eye.

With all the additional aid which the anatomical characters give, we are not a great deal furthur advanced until we have some system of arriving step by step at the wood we desire to identify. It would be rash to enter upon the controversy concerning the systematic value of these characters, and to attempt to bring them into harmony with Orders and Genera. The time for this is not yet, but for technical purposes the natural system need only be respected as far as it is useful. Therefore, an artificial system will serve our turn.

The key provided by Nördlinger makes a mere commencement, and after guiding us a little way, leaves us stranded in the midst of a large group of species which have to be dealt with one by one. The key to the European woods constructed by Hartig, and the similar one by F. Schwartz are complete, and fairly satisfactory, but are so very limited. I have used all three, and can candidly say that they are much better than nothing, but require considerable study and much practice to use. For my own use I have constructed a key on a similar principle, but use different characters for the preliminary stages. As it seems to me, amongst the woods of the broad-leaved trees the rays are the most constant character. I base my divisions upon them, first separating those woods having two kinds of rays, as many Cupuliferæ, from those which have but one. I then divide the latter into those whose rays are separated, by intervals greater or less than the transverse diameter of their larger pores—that is to say, the intervals between some may be equal to the pore diameter at the most, and conversely in the other class the intervals may be equal to the pore-diameter, but never less. Further sub-divisions, which it would be tedious to detail, are based upon the presence of soft tissue and its arrangement, followed by the arrangement of the pores, concluding with the degree of definiteness of the ring boundary. This most elusive character is one of Nördlinger's preliminary divisions, hence the difficulty of using his scheme.

The principle I have tried to follow is to start from plain or fairly obvious characters about which there can be little doubt, and to leave the more dubious ones for the end of the series, where there are fewer species to deal with, and other aids come in. By this system members of the same genus having a similar arrangement of rays, pores, and soft tissue, fall into the same ultimate group, which they do not when the ring-boundary is relied upon (vide *Platanus acerifolia* and *occidentalis*). When these ultimate groups are reached, physical and chemical characters may be employed in discrimination. The range of the weight per cubic foot, hardness, colour of the solution produced by boiling in water and alcohol, reaction with iron salts, capacity for absorption of water, phenomena produced during burning, character of the surface, whether dull or lustrous, and the particular elements, rays, pores or ground tissue which produce the effect, and lastly the colour.

In every description of wood, by a practical man, the elements of weight, hardness and colour come in. Sometimes the weight per cubic foot is given and the colour, apart from its fluctuations, is often accurately pictured, but the hardness is a quality which is practically left to our imagination. I have been so much impressed with the necessity of some means of measuring the degree of hardness, that I have constructed an instrument which is capable of giving a fairly accurate reading of the resistance to impact of a wood (not of its hardness pure and simple, because the resistance to impact is made up of elasticity, plus hardness), but it is a fair parallel to the impression of that which we call the hardness makes upon our sense of touch. I will not weary you with a description of this contrivance, but will merely mention that the principle is as follows. A steel ball of a known weight falling a definite distance upon a surface at an angle of half a right angle will fly off in a horizontal direction, and describe a curve or trajectory which will be longer or shorter according to the amount of force absorbed by the wood. A self-recording arrangement and all necessary adjustments are attached to the machine. The hard and soft zones of a wood give different readings, so that a number of trials have to be made and an average struck. I take the average of ten trials, displacing the wood five millimetres between each.

The solution obtained from boiling a small quantity of shavings is of a valuable and interesting character, full of surprises, and affording many lovely colours. The reaction with iron salts is useful in cases where the change of colour is displayed in different degrees by different kinds of tissue. The burning of wood often causes various coloured resins to exude, and affords evidence by means of the aroma, or by the ash. A familiar example is the smell of the well-known Chinese joss sticks, made from the sawdust of sandal wood, and the two Australian paving woods, jarrah and karri, may be known by their producing a black cinder and a white ash respectively.

DISCUSSION.

The CHAIRMAN thought that the method employed by Mr. Stone for identifying different timbers was of extreme simplicity. It must not be supposed to be necessary to cut fine sections of the wood to ascertain its variety; a sharp penknife and a lens were sufficient for distinguishing the different features in the structure of woods. The new departure initiated by Mr. Stone he felt certain would become of great importance in scientific work. Mr. Stone had mentioned various gentlemen who by their studies contributed materially to the knowledge on the subject, and had referred to Mr. Gamble's excellent work on the timbers of India, which would form the basis for all researches relating to Indian timbers. It was the result of work performed by himself and Mr. Gamble, in 1877 and 1878, when preparing a collection of over 900 correctly-named woods for the Paris Exhibition and other institutions. He thought Mr. Stone had set an excellent example by using only plain terms. For instance, he did not speak of medullary rays, but only of rays, which was the correct term, and he hoped that before long botanists, who were very conservative people, would condescend to use the latter term.

Prof. H. G. GREENISH said the paper had been of considerable interest to him because his daily work brought him face to face with problems analogous to those which Mr. Stone had to solve in woods. He wished to emphasise the importance of the structure, not only of woods, but practically of all vegetable organisms. He frequently had to deal with various drugs, most of which could be easily recognised with the naked eye, but when the naked eye was insufficient, a lens was used similar to that employed by Mr. Stone. He had frequently, however, to deal with cases in which even the lens was insufficient. When drugs were broken into small pieces they were much more difficult to recognise than when presented whole, a similar remark applying to leaves. Recourse then had to be made to the microscope, and even when a leaf was ground for any length of time, under the heaviest stones employed by drug millers, and reduced to an impalpable powder, by the aid of a microscope, with a few reservations, the powder of any drug used in the United Kingdom could be identified. Some tonics were prepared from certain woods, and it was important in the preparation of such drugs, that the right wood was obtained. On going to the docks and seeing large stocks of various woods, which it was said were quassia, it was of enormous benefit to be able, by adopting Mr. Stone's methods to find out whether they were really quassia of the particular kind required. He was pleased to find that evidently more was to be ascertained by simply examining the structure with the lens than he had previously anticipated, and was surprised to learn that there was such a large variety of woods brought into the market from the various colonies to be used for technical purposes. It became of the utmost importance that the men who used such woods should know that they were using the right wood. He would like to know whether Mr. Stone had found that the use of the lens was sufficient to identify the woods, or if he had had to resort to the microscope to ascertain the very fine markings in the cells of the wood, determining by that means the identity of the woods.

Mr. T. G. HILL bore out the conclusions of the reader of the paper with regard to the examination of the structure of woods for definite species. He also thought Mr. Stone's remarks with regard to botanists were perfectly true. Botanists often forgot in working out questions of purely academic importance the value of the points to those who were interested more from the economic point of view.

Mr. E. T. SCAMMELL thought Mr. Stone had rendered considerable services to the Colonies by his researches. By his knowledge he had recently been able to trace a certain wood, and to give most valuable information, which he believed would be of considerable service to the municipalities of the country, and of considerable commercial value to a number of timber-merchants present. He was glad that, in addition to himself, other representatives of Colonial Governments were present, and, on their behalf and his own, he thanked Mr. Stone for his paper, and would do everything in his power to supply him with samples of wood for the very excellent purpose he had in view. He thought Mr. Stone had rendered services of considerable commercial and economical value to all interested in the timber trade.

Dr. AUGUSTINE HENRY thought the charges brought against botanists by the reader of the paper were not altogether fair. When he began to collect plants in China, although he had no instructions to take specimens of trees, he made a collection in the first year of specimens of woods, which he sent home to Kew, but he never heard a single word about the collection subsequently, from any specialist in the study of woods. There were many collectors in almost every part of the world who would be willing to do such work if they were requested to do so. Most of the ignorance on the subject was due to the fact that there was no proper intercommunication between scientific men at home and travellers abroad, who were willing to work but did not know how to set about the matter. He had collected botanical specimens in various parts of the forests of China, first of all in the central provinces of Hupeh and Szechwan, then in Formosa and the Island of Hainan, and during the last four or five years in the province of Yunnan. There were immense forests in the very high ranges of the central provinces, ranges really branching off from the Himalayas. Through that vast unexplored region there were immense forests everywhere. At the top from 7,000 feet upwards there were great belts of coniferous forests, where trees were to be found as straight as an arrow, 200 feet in height, with a diameter of four or five feet. Below 7,000 feet various mixed forests were to be found. Even in small woods of about two acres in extent more species of trees were to be found than occurred in all Europe. In such a wood probably 100 trees of different species might be found, whereas, in Europe, there were only 70 species of trees altogether. There were at least 100 distinct species of rhododendrons known in China already, and the figure, he was sure, would be increased three-fold. Sixty or seventy species of oaks were now known in China, although it would probably be discovered in the future, that there were at least 100 or 200 varieties. At present, it was perfectly impossible to deal with forests in China in a practical way, owing to the absence of roads and railways, and there being no security for capitalists. In some places the woods were fast disappearing. About 100 years ago missionaries introduced the potato into China, and the natives, finding that it grew very well at high altitudes, were destroying the forests in order to get a miserable crop of potatoes. He had recently received a letter from a friend to the effect that the potato disease was rife, with the result that whole villages of Chinese were deserting the mountains, and there was some chance of the forests being preserved. He hoped the disease would go on and prosper.

Mr. T. F. BOURDILLON said the forests in Travancore were very extensive, including 500 or 600 different species of timber, many of them peculiar to the country. Unfortunately a similar state of things existed there as in China; the hillmen cutting down the forests in order to plant grain and tobacco. The Government was stopping them to a certain extent, and endeavouring to encourage the forests to grow up again. He thought the work being carried on by Mr. Stone, if pushed further, would be of very great assistance indeed in identifying timber.

Dr. W. SCHLICH, C.I.E., thought the systematic botanist would have to learn something from the men who, with a lens and a microscope, examined the structures of wood, and that a great deal of the present classification might have to be very considerably altered in accordance with further experience as to the similarity of the structure of the timber of different trees. Last February he read a paper before the Society, in which he demonstrated that the imports of timber into Great Britain and Ireland alone amounted to the net value of £25,000,000 per annum, and suggested that if that money, instead of being paid to people outside, could be paid to home timber growers, it would be an advantage to the country. He also pointed out that the certainty of future supplies, more particularly of particular kinds of timber, was doubtful, and that new sources of supply must be opened up. When those new sources were used it would be essential to know exactly what kind of timber came to this and other countries; and he believed Mr. Stone's classification would be of the utmost importance in supplying such information. There was no doubt the Chairman originated the study of the anatomical structure of timber in India, and the beautiful description of the 800 pieces of timber in a well-known volume was dictated by him to his two assistants. Mr. Gamble now had ready for the Press a new edition of his work, giving a description of 1,500 different kinds of timber. He was told that there were 4,700 woody plants in India, and there must be many more all over the world; and as a description of only 1,500 of these had appeared, Mr. Stone had a magnificent field of work before him. If he succeeded in getting from the Colonial Governments specimens of different kinds of timber, and prepared authenticated collections of them which could be placed in a central place, such as the Imperial Institute, the difficulties of the timber-dealer would be to a large extent removed.

Mr. STONE, in reply, said he had been greatly interested in Mr. Greenish's remarks about drugs, because they coincided with his study of woods. It frequently happened that a wood called *simaruba* was palmed off for quassia, the structures being very similar. He had not overlooked the use of the microscope, but he found that the lens and the eye were sufficient. The magnification of the slides shown was about 40 times. Specimens in the microscope were magnified too much, and all their character was lost. Although the sculpture and the walls of the cells was of great assistance, it was almost unnecessary. With regard to botanists, it was too much to expect travellers to burden themselves with specimens, but if they could supply the vernacular names and mention the colour and a few details, it would be most precious information. The report of the *Challenger* expedition, which was paid for with Government money, simply contained a list of plants with a few English names, but no vernacular names, or useful information of any kind was given. He regretted that Dr. Henry's collection had been ignored; the want of appreciation of the labours of gentlemen in such directions were extremely unfortunate. He entirely endorsed the same speaker's remarks about the forests and potatoes. It was also true that it was extremely difficult to explain the points of difference between various woods. The descriptions of Indian timber were as short as they could be and were most valuable, but some kind of key was wanted by which the wood could be traced from point to point. He intended to devote the remainder of his scientific life to that point. He fully believed in regard to Dr. Schlich's remarks, that as the timber supply declined in the Northern hemisphere other suitable sources of supply must be looked for to take the place of the gradually diminishing resources.

The CHAIRMAN, in proposing a vote of thanks to the reader of the paper, hoped the immediate result of Mr. Stone's labours would be, as suggested by Dr. Schlich, the establishment of collections of authenticated pieces of wood with their correct names. Mr. Stone had told him that he had already promised a collection to an institute in Birmingham, and he had no doubt another collection would be placed at the East Indian Docks. The practical results accruing from the presentation of a collection of a thousand species of woods to the Herbarium at Kew would be manifest to all.

The resolution was carried unanimously.

Miscellaneous.

THE BULGARIAN TEXTILE INDUSTRY.

The textile industry in Bulgaria has attained a certain degree of development, and its production is now estimated at an annual value of £240,000. Up to the year 1899, there were no spinning mills in the Principality, but in May of that year, an Anglo-Bavarian Spinning Company was established at Varna, with a capital of £48,000. This enterprise has, according to the *Revue d' Orient*, been successful, and it is in contemplation to open a branch either at Philippopolis or Bourgas. The State has rendered every assistance to the company, under the law for the encouragement of national industries; the machinery introduced from abroad is admitted into the country, free of customs duties, and its products benefit by reduced tariffs on the State railways. The importation of cotton goods into Bulgaria, which previously amounted in value to between £160,000 and £200,000 annually, now shows a decided tendency to fall of, owing to the competition of these spinning mills. The Bulgarian textile industry has shown the greatest development in the departments of Philippopolis, Carlovo, Sevlievo, Tirnovo, Sliven and Zagora. Its principal products are a cloth known as *chayak*, somewhat resembling cashmere; a coarse white cloth called *aba*; various articles of lace and trimmings, and carpets known as *kilims*. The exports of articles of Bulgarian textile production are of some importance, and the value averages roughly £120,000 annually. Their principal markets are Turkey in Europe, Roumania, and Servia. The Bulgarian Government does everything possible to encourage this industry. Besides the military uniforms, which are all made of cloth produced in the country, a ministerial decree has laid it down that all the *employés* of the State, and of the communes, are only to wear clothing made of the national products; any infringement of this regulation is visited with a fine. When it is considered that public functionaries and *employés* in Bulgaria constitute nearly 50 per cent. of the probable buyers of foreign-made clothing, it is at once apparent that the importation of such clothing must have fallen off very considerably, notwithstanding the fall in prices. According to recent official figures, these imports fell off in value from £888,000 in 1896, to £50,000 in 1897, £34,400 in 1898, and £27,320 in 1899. Tne Government also encourages, as far as possible, the manufacture of carpets (*kilims*). In 1899, a ministerial decree prescribed that a preference should be given to these articles when carpets are required for public offices. Finally, it may be mentioned that a school has been opened at Slivno, to give instruction in all branches of the textile industry.

Notes on Books.

BOOKBINDING AND THE CARE OF BOOKS: A Text-Book for Bookbinders and Librarians. By Douglas Cockerell. (The Artistic Crafts Series of Technical Handbooks, edited by W. R. Lethaby, No. 1.) London: John Hogg, 1901.

Mr. Douglas Cockerell, a member of the Committee on Leather for Bookbinding, has produced a practical work on the art and craft of bookbinding, in which the mode of carrying out the various processes is fully explained by the help of a series of illustrations from drawings by Mr. Noel Rooke. Not only are the whole series of operations necessary for the "extra" binding of a book described, but also practical attention is paid to such additional subjects connected with the bookbinder's work as mending splitting paper, metal on bindings, clasps, covering in embroidery, &c. The three great divisions of the binding of a book, viz., forwarding, covering, and finishing, are exhaustively treated. On account of the injury done to the paper by the modern use of tinned iron wire when books and magazines are first issued the work of the forwarder is largely increased. As the author says, "Generally speaking, the sections of a book cased in cloth by modern methods are so injured as to make it unfit for permanent binding unless an unreasonable amount of time is spent upon it."

With respect to the various coverings, Mr. Cockerell gives the latest information as to the unsatisfactory condition of much of the leather at present in the market, and, when enumerating the leathers, he writes of calf: "Modern vegetable-tanned calf has become a highly unsatisfactory material, and until some radical changes are made in the methods of manufacturing it, it should not be used for bookbinding." It is to be hoped that radical changes may be made in the manufacture, and that calf may again hold that high position as a binding material which it once held.

"Vellum covers may be limp without boards, and merely held in place by the slips being laced through them, or they may be pasted down on boards in much the same way as leather." The former of these plans produces one of the most lasting of bindings, and the latter, one of the most unsatisfactory, as if the book is held in the hand before a fire, the boards will warp badly.

The author enters fully into the designing of tools and their use, and the mode of forming patterns by combining tools. One of the most important duties of the binder is to letter well, and good lettering is a mark of the good binder. There are many difficulties to be overcome, largely due to the unequal lengths of the words and the varying widths of the books. Mr. Cockerell gives alternative modes of lettering.

The second part deals with the injurious influences to which books are subjected, and the best way of preserving old bindings. Here special use has been made of the report of the Society of Arts' Committee.

The glossary at the end is useful, and in several cases reference is made to the figures used in the book, and thus the explanation is made more clear. Besides the figures in the text, there are collotypes of some fine old and modern bindings.

Obituary.

SURGEON-GENERAL ROBERT HARVEY, M.D., C.B.—News of the death of Surgeon-General Harvey, Hon. Surgeon to H.E. the Viceroy of India, and Director-General of the Indian Medical Service, has just been received from India. He was the eldest son of the late Alexander Harvey, of Broomhill, Aberdeenshire, and was born at Aberdeen on the 10th March, 1842. He studied at Aberdeen and Glasgow, taking the degree of M.D. at the former university, which subsequently conferred upon him the honorary degree of LL.D. He entered the Bengal Medical Service in 1865, and served with the Bhootan expedition immediately afterwards. He saw much active service, and after acting for some time as Inspector-General of Civil Hospitals, Bengal, he was in 1895 appointed Principal Medical Officer to the Punjab forces. Three years later he became Director-General of the Indian Medical Service. Surgeon-General Harvey was elected a member of the Society of Arts in 1899.

General Notes.

COTTON IMPORTS.—The number of bales of cotton imported into the United Kingdom during the year ended the 7th November, was 154,206, and the number imported during the 45 weeks ended the 7th November was, according to the Board of Trade Journal, 2,562,859. As regards exports, the figures are, for the week ended the 7th November, 4,745 bales, and for the 45 weeks, 273,941.

GOLD COSAT GOLD INDUSTRY.—The Colonial Office have communicated to the Press an extract from the address of the Governor of the Gold Coast to the Cape Coast Chamber of Commerce in September last on the gold output, which has been steadily decreasing for some years past. With respect to samples of auriferous quartz, the following information was given to the governor by a gentleman who saw a native who manufactured samples: "The method employed was that of a blowpipe, after the manner of native jewellers; just in the same way that the native jewellers blow the little beads of gold from a blowpipe in their ornamental beadwork, that gentleman was using a jeweller's pipe to blow little beads of gold into the crevices of barren quartz. Whether he was sending them down to Cape Coast or not I do not know, but he certainly was prepared to take certain sums for 'knockdoor money' before he would show any possible purchaser the supposed concessions from which he obtained the sample."

SELF-HARDENING STEELS.—The following remarks by Dr. T. Kirke Rose were omitted from the end his fourth Cantor Lectures on "Alloys" in the last volume of the *Journal* from want of space, and are printed here as they refer to a distinct department of the subject:—"Some researches carried on by Madame Currie,* M. Osmond,† and M. Dumas‡ on the steels which may be used for magnets have resulted in a great addition to our knowledge on the subject. Carbon steels, as is well known owe their magnetic properties to the hardening operation. There are, however, a remarkable series of alloys of iron with manganese, nickel, chromium, and tungsten, which even if slowly cooled assume properties similar to those of hardened carbon and steel and so are known as "self-hardening." Among these, one studied by M. Osmond, containing 7·80 per cent. of manganese and 0·46 per cent. of carbon, when heated to 750° and allowed to cool slowly, though hard, has no permanent magnetism. When plunged into liquid air, however, and allowed to remain until its temperature has fallen to that of the medium in which it is placed, it becomes capable of a high degree of permanent magnetisation. Some other self-hardening alloys of iron are not magnetic at all, and perhaps the strangest of these is that containing 25 per cent. of nickel. This alloy, if cooled from a molten state, is not attracted by an electro-magnet. I have here, however, a bottle of liquid air kindly given me for the purpose of this demonstration by Mr. Lennox. After being cooled in the liquid for a few minutes, the bar of nickel steel will be strongly attracted by the magnet. [The experiment was here made.] The nature of the change which this particular steel has undergone in the liquid air, has not been examined, but no doubt there is a profound change of structure similar to that observed when martensite is subjected to the same low temperature."

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* "Metallographist," vol. 1, pp. 107, 229, and 274.

† *Comptes Rendus*, June, 19, 1899.

‡ " " July 3, 1899.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

DECEMBER 11.—"Aluminium." By PROFESSOR ERNEST WILSON, M.Inst.E.E.

DECEMBER 18.—"Range Finders." By PROF. GEORGE FORBES, F.R.S. SIR FREDERICK BRAMWELL, Bart., F.R.S., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

WILLIAM JAGO, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." Four Lectures. To be followed by practical demonstrations.

LECTURE III.—DECEMBER 9.—Sugar Confectionery—Composition and properties of sugar; cane sugar, beet sugar, glucose, maltose—Principles of sugar boiling—Various sugar working operations—Sweets, their nutritious value. *Practical Demonstration*—Sugar working and sweet making.

LECTURE IV.—DECEMBER 16.—Confectionery—Flavoured by fruit, cherries, currants, raisins, nuts, walnuts, almonds; preserved fruits, jams, essential oils, lemon, orange, almonds; fruit essences; vanilla—Their composition and properties. *Practical Demonstration*—Piping and ornamentation of cakes.

[*The practical demonstrations are subject to alteration.*]

SAMUEL RIDEAL, D.Sc., F.I.C., "The Sterilisation of Water." Four Lectures.
January 13, 20, 27, February 3.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) William Jago, "The Chemistry of Confectioners' Materials and Processes." (Lecture III.)
Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Mr. Rew, "The Development of the Pedigree Live Stock Interest."
Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. H. T. Thomas, "The Maroons of Jamaica."
Surveyors, 12, Great George-street, S.W., 8 p.m. Prof. W. Somerville, "Artificial Manures."
Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. J. Logan Lobley, "The Preparation of the Earth for Man's Abode."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Francis Bond, "Mediæval Monks and Monasteries."

TUESDAY, DEC. 10...Civil Engineers, 25, Great George-street, W., 8 p.m. 1. Discussion on Mr. John A. Aspinall's paper, "Train-Resistance." 2. Mr. Bryan Donkin, 'Motive-power from Blast-furnace Cases."
Asiatic, 22, Albemarle-street, W. 4 p.m.
Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Photographic, 66, Russell-square, W.C., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C.
Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. H. A. Kennedy, "The French Canadians."

WEDNESDAY, DEC. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Prof. Ernest Wilson, M.Inst.C.E., "Aluminium."
Royal Literary Fund, 7, Adelphi-ter., W.C., 3 p.m.
United Service Institution, Whitehall, S.W., 3 p.m. Dr. M. J. Farrelly, "Our Hold on South Africa after the War."
Central Chamber of Agriculture (at the HOUSE OF SOCIETY OF ARTS), 11 a.m.
Biblical Archæology, 37, Great Russell-street, W.C. 8 p.m.

THURSDAY, DEC. 12...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Patrick Manson, "Conveyance of Malaria by the Mosquito."
Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Professor E. Wilson's paper, "The Physical Properties of certain Aluminium Alloys and some Notes on Aluminium Conductors." 2. Mr. Arthur Wright, "Some Principles Underlying the Profitable Sale of Electricity."
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, DEC. 13...North-East Coast Institute of Engineers and Shipbuilders, Sunderland, 7 p.m.
Astronomical, Burlington-house, 8 p.m.
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Professor Thomas R. Lyle, "Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the equivalent Radius of a Coil." 2. Dr. Barton and Mr. S. C. Laws, "Air Pressures used in playing Brass Instruments." 3. Mr. E. B. H. Wade, "A New Hygrometric Method."

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FRIDAY, DECEMBER 13, 1901.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday afternoons, January 1 and 8, 1902, at 5 o'clock, by Sir Henry Trueman Wood, M.A., Secretary of the Society, on "Photography and its Applications."

Lecture I. — Photographic Optics — Pinhole Photography—The Lens: its Defects and their Correction—Instantaneous Photography—Movements of Animals, &c.—Photography by the Electric Spark—Flying Projectiles—Falling Drops—Sound Waves—Stellar Photography—Photography and the Spectroscope—Photography of the Unseen — Photography the Hand-maid of Science.

Lecture II. — Photographic Chemistry — The Sensitive Surface—The Negative and its Development—Photographic Printing—Photography and the Printing Press—Reproduction of Colour by Photography — Photography in Colours — Miscellaneous Applications.

The Lectures will be fully illustrated by experiments, photographs and lantern slides.

Members who desire tickets for the course are requested to apply for them at once.

Each member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received.

CANTOR LECTURES.

On Monday evening, 9th inst., Mr. William Jago, F.C.S., delivered the third lecture of his course on "The Chemistry of Confectioners' Materials and Processes."

At the conclusion of the lecture, a demonstration of the manufacture of confectionery was given by Messrs. Clarke, Nickolls and Coombs.

The lectures will be published in the *Journal* during the Christmas recess.

NEXT WEEK.

Monday, December 16, 8 p.m. (Cantor Lecture) — William Jago, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." (Lecture IV.)

Wednesday, December 18, 8 p.m. (Ordinary Meeting)—Prof. George Forbes, F.R.S., "Range Finders."

Further details of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, December 5th, The Right Hon. Sir Henry Drummond Wolff, G.C.B., G.C.M.G., in the chair. The paper read was, "The New Trade Route to Persia, by Nushki and Seistan." By Edward Penton, B.A.

The paper and report of the discussion will be published in a future number of the *Journal.*

FURNITURE EXHIBITION AT BUDAPEST.

The Board of Education have forwarded to the Society of Arts, the following copy of a despatch addressed to the Secretary of State for Foreign Affairs, by H.M. Consul-General at Budapest, relating to a projected Exhibition of Modern English Furniture, at the Hungarian Museum of Decorative Art, at Budapest:—

[COPY.]

Budapest,
No. 16. October 30th, 1901.
Commercial.

My Lord,—I am informed by Mr. de Radisics, Director of the Hungarian Museum of Decorative Art at Budapest, that it is proposed to arrange for an exhibition at that Institution of Modern English Furniture, to open in March next.

In case inquiries upon this subject should be addressed to Your Lordship's Office by intending exhibitors, I beg leave to state that the Museum in question is supported by the Hungarian Government, Mr. de Radisics being its official head. Exhibitors may, in consequence, count with safety upon meeting with equitable and considerate treatment in every respect.

In particular, I am authorised by Mr. de Radisics, to give the assurance, that any stipulation forbidding copies, photographs, or drawings being made of objects entrusted to him foi exhibition, will be scrupulously observed.

I have, &c.,
(Signed) C. Conway Thornton.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 11th, 1901; Lieut.-Colonel ALLAN CUNNINGHAM in the chair.

The following candidates were proposed for election as members of the Society:—

Bullough, Sir George, Kinloch Castle, Isle of Rum, Scotland.
Clark, John Spencer, 110, Boylston-street, Boston, Mass., U.S.A.
Hepburn, Arthur Elphinstone, Soberton Rectory, Bishop's Waltham, Hants.
Heyl-Dia, George Edward, Warrington, and 32, Victoria-street, S.W.
Miller, Luiz D., The Firs, Simonstown, South Africa.
Moulvi Sayid Ashrafvddin Ahmad Khan Bahadur, Hooghly Imambara, Hooghly, Bengal, India.
Sabin, Alvah Horton, 45, Broadway, New York, U.S.A.

The following members were balloted for, and duly elected members of the Society:—

Barnett, Joseph, Erskine Chambers, Lincoln inn, fields, W.C.
Clarke, R. F. D., care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.
Falk, Salomon, Messrs. Falk, Stadelmann and Co., Limited, 83 to 87, Farringdon-road, E.C.
Gilkes, Edward, 205, Charlotte-street, Lacytown, Georgetown, Demerara, British Guiana.
Hodgkinson, Thomas Ayscough, 11, Bedford square, W.C. and 3, Queenhithe, E.C.
Höfler, William, 26A, Soho-square, W.
Lamb, Lieut.-Col. Thomas, 8, Claverton-street, S.W.
Lebbe, A. R. Casse, 1, Trincomalie-street, Kandy, Ceylon.
Maskelyne, J. Nevil, Royal Artillery Mess, Shoeburyness.
Ochs, Albert Lionel, 25, Green-street, Park-lane, W.
Sainsbury, Stafford Fox, 136, Regent-street, W.
Sinha, Rai Bahadur Shanker Dyal, Kesath, Dumraon, Shahabad, India.
Shillitoe, Thomas, Beodericsgueorth, Bury St. Edmunds.
Stewart, Angus Matheson, Sanchez, San Domingo, West Indies.
Wilkins, Frederick John, 11, Kensington High-street, W.

The paper read was—

ALUMINIUM.

BY PROFESSOR ERNEST WILSON, M.I.E.E.

About nine and a-half years have elapsed since a paper was read before this Society on the subject of aluminium. Since that time great strides have been made in the manufacture and output of the metal. Not so many years ago aluminium almost ranked as a precious metal, the price being as high as 60s. per pound. In 1889 the price was 20s. In 1892 it was 2s. 6d., and at the present time it is 1s. 2d. per pound, or £130 per ton. The world's output has increased until in the year 1900 no less than 5,000 tons were produced by plant having a combined output of about 25,000 horse-power, and representing a capital of over £2,000,000 sterling. The world's output of copper during 1900 was about 500,000 tons, so that the output of aluminium was about one per cent. of copper. It was pointed out by Mr. N. Brown, at the British Association this year, that the world's demand for copper in 1900 would only have run to about 150,000 tons, if it were not for new applications of which electricity was the chief. Since it is as a conductor for electricity that aluminium is specially attracting the attention of engineers at the present time, we see that the output of aluminium can be greatly increased without seriously affecting copper, either as to price or output.

As far as is known, aluminium exists nowhere uncombined in the metallic state, so great is its affinity for other substances. Its production is essentially a chemical operation. A ferruginous hydrate known as bauxite is the ore at present used from which to extract aluminium, but the metal is largely diffused in the earth. Its silicate is one of the chief constituents of clay; its fluoride, in conjunction with sodium, forms cryolite, and it is met with in felspar.

I do not propose to describe what may be termed pure chemical processes for the production of aluminium, as at the present time all aluminium may be said to be produced by electrolysis. In fact, the successful production of the metal is due to the introduction of this process, and a few words on the development of the industry should be given.

Progress in Manufacture.—The process was patented in 1886-87 by Hall in America, and Héroult in England and France. In 1888

Hall was at work with it on a commercial scale at Pittsburg; in 1891 the plant was removed to New Kensington, and was gradually enlarged to 1,500 horse-power, and in 1894 works of 5,000 horse-power were erected at Niagara Falls. In 1890 the Hall process operated by steam power was installed at Patricroft, Lancashire, but the French and Swiss works operated by water power in 1894 ruined the enterprise. About 1897 the machinery at St. Michael passed into the hands of Messrs. Pechiney, and was soon increased to 3,000 horse-power, and here aluminium is still being manufactured by the Hall process. At Neuhausen about 4,000 horse-power is obtained from the Rhine, at Rheinfelden about 2,000 horse-power, while about 3,000 horse-power are used by the Sociétè Electro-Metallurgique Française, of La Praz, near Modane. In 1895 the British Aluminium Company was founded to mine bauxite and manufacture alumina in Ireland, to reduce the aluminium at Foyers, and to refine and work up the metal at Milton, in Staffordshire. By the end of 1899 plant of 7,000 horse-power had been installed at Foyers; some of it, however, being employed for the production of calcium carbide. In order to meet the demands of the Pittsburg Reduction Company, and as an indication of what is expected of aluminium, it may be mentioned that the Niagara Falls Company are installing two new turbines. Space does not permit of further description; but the above remarks are sufficient to show how rapidly the electrolytic process has been developed.

The Electrolytic Cell.—A short description of the Héroult cell which is used at Foyers may be here given. It consists of a square iron or steel box lined with carbon, at the bottom of which is a cast-iron plate connected with the negative pole of the dynamo. The positive pole of the dynamo is connected to a bundle of carbon rods suspended from overhead and capable of vertical adjustment. The cell is filled with cryolite, which becomes molten by the passage of the electric current, and then the powdered alumina is fed in continuously as long as the operation proceeds. The potential difference between the terminals of each cell is from 3 to 5 volts, and the current overcomes the chemical affinity of the aluminium oxide besides heating the electrolyte. The operation is essentially a dissociation of alumina into aluminium, which collects at the cathode or negative plate, whilst the oxygen, which is evolved at the anode or positive pole, combines to form carbon monoxide and dioxide. The current density is about 700 amperes per square foot of cathode, and the working temperature varies from 750° to 850° C.

It is interesting to note that in 1892, Mr. Addenbrooke gave the production of aluminium in terms of energy by the Hall process at 1 lb. aluminium per 22 electric horse-power hours.* The British Aluminium Company give 1 to 1½ lbs. aluminium per 24 electric horse-power hours.†

Alloys.—Aluminium can combine to produce an enormous number of alloys, some of which, containing 1 to 2 per cent. of other metals, combine the lightness of aluminium with greater hardness and strength. Other alloys containing from 90 to 99 per cent. of other metals exhibit properties of those metals much improved for certain purposes. Much as has been already done, much more remains, and the alloy producing property of aluminium opens up a vast field for research. It must be remembered that electrolytic aluminium has only been known during the last few years, and now that its purity can be controlled on a large scale, consistent results may be obtained. The purest aluminium obtained commercially contains traces of iron and silicon, giving about 99·6 per cent. of aluminium in the finished product. All aluminium may be said therefore to be used in the alloyed state.

Commercially Pure Aluminium. — The colour of commercially pure aluminium depends upon the temperature at which the metal has been treated. Cast in chill moulds and cooled quickly, or cast in green sand at a low temperature, the metal has a bright white colour nearly like that of silver. When cast too hot in dry sand, the colour is grey, like lead, or bluish, like zinc. The fracture grain differs considerably according to the method of casting, cooling, or working. When drawn, rolled, or forged, the metal shows a silky grain. The specific gravity of commercially pure aluminium varies at atmospheric temperature from 2·56, when cast in sand, to 2·71, when hammered or drawn. Compared with other metals, its specific gravity is as follows:—

Aluminium	1
Zinc	2·7
Tin	2·76
Cast iron	2·91
Nickel	3·37
Copper	3·37

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[*] See "Journal of the Society of Arts," May 13, 1892, p. 662.

[†] See "Engineering," Sept. 27, 1901, p. 464.

Silver	3·98
Lead	4·30
Gold	7·31
Platinum	8·15

The following figures are taken from a series of tests made at King's College, London, for the British Aluminium Company.*

Commercially pure aluminium (containing ·31 per cent. Fe and ·14 per cent. Si) has a specific resistance of

$$\left\{\begin{array}{l} 2{\cdot}59 \times 10^{-6} \text{ legal ohms at 0 deg. C.} \\ 2{\cdot}762 \times 10^{-6} \text{ ,, ,, 15 ,,} \end{array}\right\}$$

a temperature co-efficient .00393 and linear co-efficent of expansion ·000023 between 16° and 100° C. Weight for weight the conductivity of this aluminium is double that of copper, or, for equal conductivity, half the weight of aluminium would be required; or for a given length of conductor carrying the same electric current with the same loss, that is, the same fall of potential, the relative weights would be as 1 of copper to ½ of aluminium. This necessarily involves a great saving in transport, and there is the additional advantage that fewer and lighter poles are required for erecting overhead conductors.

Taking the specific resistance of aluminium at 2·76, and copper at 1·696 × 10^{-6} ohms (Matthiessen's standard) at 15° C., the diameter of the aluminium wire will be 1·27 that of the copper.

This commercially pure aluminium has, when in the form of wire ·126 in. (3·2 millimetres) in diameter, a breaking load of 28,200 lb. (12·6 tons) per square inch, a limit of elasticity 19,376 lbs. (8·65 tons) per square inch, and percentage extension ·19 within the limits of elasticity with an applied force of 16,250 lbs. (7·2 tons) per square inch.

Light Aluminium Alloys.

The following is a brief *resumé* of the series of tests above alluded to, and made upon twenty-four different alloys. The object was to find the effect of alloying upon the electrical and mechanical properties of aluminium, so that a comparison should be made with the corresponding properties of commercially pure aluminium.† It should be noted that the iron and silicon which are always present, are not constant in quantity.

Copper.—As soon as the proportion of copper (1·5 to 2 per cent.) is sufficient to give a breaking load of 40,000 and limit of elasticity of 33,000 lbs. per square inch, the specific resistance rises to 3·3 from 2·7 × 10^{-6} ohms for pure commercial aluminium at 15° C. The temperature co-efficient falls to ·0030 from ·0040, the linear co-efficient of expansion is ·000024 as against ·0000234. Not much is gained in tensile strength by increasing copper from 1·5 to 2·5 per cent.

Zinc.—It cannot be said that the addition of zinc up to 2 per cent. improves the tensile properties of this alloy. In fact, with 2 per cent. Zn the breaking load has fallen below what it is with 1·2 per cent. Zn. For the same proportions, the conductivity of the zinc alloy is greater than the copper. The co-efficient of expansion falls slightly with increase of zinc, whereas it rose with increase of copper.

Nickel.—This metal has a marked effect upon the breaking load, but the limits of elasticity remain low. For instance, 2·2 per cent. Ni. gives a breaking load of 38,600 and limit of elasticity 20,300 lbs. per square inch.

Nickel-Copper.—The alloy containing 1·29 per cent. Ni, and 1·08 per cent. Cu, gives a breaking load of 45,900 and limit of elasticity 36,600 lbs. per square inch—the highest of the series. This alloy is characterised by its comparatively low per-centage extension (·146 with 16,250 lbs. per square inch), its high co-efficient of expansion (·0000252), and its low temperature co-efficient (·00178). Its specific resistance is 3·41 × 10^{-6} legal ohms at 15° C.

Nickel-Iron.—The alloy containing 2·6 per cent. Fe, and 1·39 per cent. Ni, gives 42,200 breaking load, and 24,400 limit of elasticity. Its specific resistance is 3·24 at 15° C., and its temperature co-efficient (·0032) is nearly double that of the alloy last quoted. The co-efficient of expansion (·0000222) is as small as any of the series.

Nickel-Zinc.—Five of these alloys have been tested. The greatest breaking load is 36,000, and the limit of elasticity remains low. The alloy containing ·83 per cent. Ni, and ·90 per cent. Zn. gives a comparatively low specific resistance, namely, 3·03 × 10^{-6} ohms at 15° C.

Copper - Zinc.—Two of these alloys have been tested, and they reveal nothing remarkable.

Iron - Manganese.—The alloy containing ·56 per cent. Fe. and 1·78 per cent. Mn. has a breaking load 35,300 and limit of elasticity 24,400 lbs. per square inch. The specific resistance is high.

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* See "Journal Inst. Elec. Eng." Nov. 28, 1901, for full particulars.

† *Ibid.*

Aluminium as a Conductor of Electricity.

The use of aluminium as a conductor, is engaging the attention of engineers at the present time, and already large quantities have been installed, to transmit power on a large scale. A full description of all the long-distance transmission schemes would be out of the question here. The following are brief notes to give a general idea of what has been accomplished. At Northallerton, England, 4 miles of overhead aluminium wires are employed. Screwed socket joints have proved successful. At the Snoqualmie Falls, 20 miles of overhead conductors convey current to Renton, where the line divides, one half going to Seattle, and the other to Tacoma. About 139,000 lb. of aluminium are employed. The horse-power is 12,000, and the voltage is 30,000. McIntire joints are employed; they consist of a tube 9 in. long, of aluminium, flattened, and large enough to enclose both wires; by special clamping tools, three complete twists are given, and the joint is complete. The Blue Lakes transmission scheme has 43 miles of overhead wires. The poles are 132 feet apart. As indicating the satisfaction given by aluminium, it may be mentioned, that in the new line, about 1,000,000 lb. of aluminium will be required in the form of stranded conductors, $\frac{3}{4}$ in. in diameter. The Pittsburg Reduction Company have received orders for 150,000 lb. of aluminium, for the feeders on the North-Western Railway, Chicago. The Hartford Electric Light Company have 33 miles transmission, 2,000 horse-power at 10,000 volts, three-phase. The cable, $\frac{3}{4}$ in. in diameter, consists of seven strands. The Kansas City and Leavenworth Electric Railway line are using 76 miles of aluminium cable. At Waterport, U.S.A., a 6½ miles transmission is employed. The conductor consists of a seven-stranded cable, supported on 30 feet poles, 100 feet apart. The Niagara Falls Power Company has about completed its second power transmission line, between the Falls and Buffalo. The three-phase current is transmitted by three aluminium cables, each composed of 37 strands. The span between the poles, which in the old copper lines, is 75 feet, averages 112½ feet in the aluminium line. An electrical transmission plant has been completed in the valley of Pompeii, near Naples, in which aluminium is employed for the line wires. Three lines emanate from the power house—2 miles, 9 miles, and 2 miles long, respectively. In Provo Canyon, three aluminium cables, each of seven strands, transmit over 40 miles to Tintic, which is connected to Mercur, 30 miles distant, and electric current is transmitted to Mercur *via* Tintic, as readily as by the direct line between Mercur and Provo. In this manner, if one line is out of order, power can be transmitted by the other.

Sir W. H. Preece and Mr. Gavey have pointed out that breaks occurred in an aluminium telegraph wire $\frac{1}{8}$th in. diameter, in a strong wind.* The opinion expressed is, that these breaks are due to want of uniformity in manufacture, since they do not occur at the insulators or joints. It is noteworthy, that the power transmission lines apparently do not break, and the author thinks that smallness of diameter may also have something to do with it. The total tensile strength varies as the square of the radius, whereas the surface exposed to wind, snow, ice, &c., varies as the radius only.

In justice to aluminium, it should be stated that, since the Post Office experiments were made, uniformity in the manufacture has been improved. I am informed by the British Aluminum Company, that recently erected conductors at Larne have withstood the recent severe storm without breaking. They also state that, on the occasion of the breakages, which occurred in the Post Office line, there were breakages in some of the copper wires erected in the same district.

So far as the effects due to gravity and temperature are concerned, aluminium is on an equal with copper. These light aluminium alloys can have a limit of elasticity exceeding that of copper, their percentage extension under a given load within the limit of elasticity is greater (about twofold) than copper, and the linear co-efficient of expansion, is greater. The properties of the elastic catenary, together with the superposed effect of change of temperature, have been examined, and they show that the greater lightness and greater percentage extension counteract the effects of greater linear co-efficient of expansion.

For single small-sized wires, where great tensile strength is required, Ni.-Cu. alloys might be tried and further investigated with advantage, but a sacrifice must be made on the part of conductivity. For large single or stranded conductors, the pure commercial aluminium should be found sufficiently strong, and its conductivity is a maximum.

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* See "Journal Inst. Elec. Eng.," vol. xxx. p. 359, and "Engineering," vol. lxxii., p. 436.

Corrosion.—The subject of corrosion is one of great importance, especially in districts where the air is vitiated by chlorine, &c. I have specimens of conductors here which have been exposed to atmospheric conditions, and used at the same time to transmit electric current. One of them has been in use for four years at Foyers, and it cannot be said that it has seriously suffered from corrosion. Mr. Kershaw* has exhibited samples of conductors which have been exposed to atmosphere at St. Helens, where there are chemical works.

Price.—The net price of aluminium is now less than £130 per ton. Copper stood at £73 (less 2½ per cent.) per ton, on November 5, 1901. For equivalent conductivity, the price is slightly in favour of aluminium. If the world's output of aluminium were doubled, it would only be about 2 per cent. of the world's output of copper,† so that a considerable reduction in the price of aluminium might be effected without disturbing the price of copper.

There may be cases, such as castings, where the weight of a given volume may govern its financial value. Copper being 3·37 times as heavy as aluminium, it follows that whenever aluminium costs less than 3·37 times copper, it is cheaper volume for volume.

Insulated Conductors.—The diameter of an aluminium conductor of the same total conductivity as a copper one is, as we have seen, as 1·27 to 1, and the cross-sectional area is as 1·61 to 1. For high tension work, it has been pointed out‡ that the insulation on two cables of the same type, the one of aluminium and the other of copper, might cost less in the case of aluminium for the same disruptive resistance. In this country this is a point of considerable importance if underground insulated feeders have to be used instead of bare overhead conductors in long distance high tension transmissions. As a bare conductor for switchboard bus-bars, &c., aluminium should be found useful, and it is being used for switches where the inertia of the moving parts should be small.

Jointing of Aluminium.—It has been urged against aluminium that it gives trouble in jointing. The ordinary metals are strongly electro-negative to aluminium, so that if other metals than aluminium be used in jointing, galvanic action will occur in the presence of moisture. In the above power transmissions, mechanical joints have been made with success and need not be further considered here. With proper precautions, aluminium wires can be welded either by the use of the blow-lamp or electrically. The following tests will show that welding can be successfully accomplished. The original trolley wire (8 section) has an area of ·135 square inch, and a breaking load of 1·6 tons on that section, with 11·3 per cent. extension. The welded joint gave 1·2 tons breaking load, with 8 per cent. extension, the joint not being broken. An aluminium wire, ·516 in. in diameter, having a breaking load of 3,449 lbs., with 14 per cent. extension, gave 2,912 lbs. breaking load, when welded with 20 per cent. extension.

Two processes for welding aluminium, says the "Electro Chemist and Metallurgist," have recently been announced. The Heraeus process (the invention of W. C. Heraeus, of Hanau), was represented in the German section of the Paris Exhibition, by a collection of wires, rod, sheet vessels, &c., with perfectly welded seams. The operation consists of cleaning the surfaces of the metal to be joined, laying them together and heating them carefully to the temperature at which the metal commences to soften, keeping at that temperature and meanwhile hammering together to a perfect weld. It is important that the temperature be kept constant. If it rises too high the metal becomes short or granular, and commences to oxidise, a condition which renders the weld useless. The second process is the invention of Mr. Sherard Cowper-Coles. Some specimens of welds made by this method were shown at a recent meeting of the Royal Institution. The specimens exhibited showed that they could bear severe bending tests, without showing any signs of fracture. No details are at hand of the method of welding, but it is stated that it is not electric in nature, and that no flux or solder of any kind is used. Tests of tensile strengths with rods ¼-in. in diameter, showed an elastic limit of about 20,000 lbs. per square inch for the unwelded rods, and 12,500 for the welded rods. The breaking strength of both being about 24,000 lbs.

I am informed by the British Aluminium Co., that independently of the above named experimenters, this method of welding aluminium has been in use for some years at the company's works.

I have here specimens of soldering and welding, which show that both processes can be successfully carried out. With regard to aluminium solder, I may state, that as used on the specimens exhibited, it consists of 28 lbs. block tin, 14 lbs. phosphor—tin (10 per cent. phosphorus), 3·5 lbs. lead, and 7 lbs. spelter. The following instructions should be followed when soldering aluminium.

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* *See* "Journal Inst. Elec. Eng.," vol. xxx., p. 348.

† *See* "Engineering," vol. LXXII, p. 436.

‡ See "Journal Inst. Elec. Eng." vol. xxx., p. 646. The reader is referred to the "Electrical Review," August 23rd, 1901, for a description of mains which might be considered in connection with aluminium.

In using the above aluminium solder, it is necessary to bear in mind that upon exposure to the air, a slight film of oxide forms over the surface of the aluminium, and afterwards protects the metal. The oxide is the same colour as the metal, so that it cannot easily be distinguished. The idea in soldering, is to get underneath this oxide whilst the surface is covered with the molten solder. With the following procedure, quick manipulation is necessary:—

1. Clean off all dirt and grease from the surface of the metal with a little benzine.

2. Apply the solder with a copper bit, and when the molten solder is covering the surface of the metal, scratch through the solder with a little wire scratch brush.

By this means the oxide is broken up on the surface of the metal, underneath the soldering, and the solder containing its own flux, takes up the oxide, and enables one, so to speak, to "tin" the surface of the aluminium. After this has been done, the soldering is quite easy.

Melting and Casting.—Aluminium can be melted in plumbago or sand crucibles without becoming brittle or taking up silicon, provided that the temperature does not much exceed 626° Cent. or 1,160° Fahr., its melting point. The shrinkage of pure aluminium is .20 in. to the foot, as compared with ·187 in. for copper.

Aluminium for Iron and Steel Founders.—The addition of aluminium to iron or steel has the great advantage of keeping the metal more fluid in the ladle, thus saving by the avoidance of blowholes. At high temperatures the metal decomposes nearly all metallic oxides, and prevents blowholes by combining chemically with the gas which forms the holes. Its action is stated to be about twenty times as powerful as silicon, and the resultant steel is superior in toughness and ductility. The quantity to be added varies according to the iron used. Generally the amount runs from 2 lb. to 5 lb. per ton of iron.

Rolling and Forging.—The great ductility of aluminium makes it easy to work with rolls. Rolled sheet aluminium ·001 in. thick is used for decorative purposes. In fact, leaf aluminium may be said to have replaced leaf silver. It can be forged easily either cold or warm. Aluminium containing much silicon and iron can only be forged with great difficulty.

Hardening and Annealing.—The hardness of aluminium varies according to its purity, the purest metal being softest. Ordinary 98 per cent. aluminium is about as hard as copper. Aluminium becomes harder the more it is worked by rolling, drawing, stamping, or hammering. The metal must be annealed in a closed muffle, and must not come in contact with the open fire.

Drawing and Stamping.—Professor Thurston places aluminium as sixth in the order of ductility, being preceded by gold, silver, platinum, copper, and iron, but it is doubtful if it does not reach as high as iron. Aluminium can be pressed or stamped under the drop hammer, hot or cold. Very fine effects can be produced by first burnishing the metal and then stamping in polished dies.

Heavy Alloys—Aluminium Bronzes.—In 1889 and 1890 papers were read before the British Association on aluminium bronzes. It was then pointed out by Mr. J. H. J. Dagger, F.C.S., F.I.C., that for artillery, small arms, propeller blades, stern rudder frames and hydraulic work, the non-corrodible properties and great strength of these alloys rendered them most valuable. Aluminium bronze propellers have been successfully employed for high-speed torpedo catchers. The two classes of bronze most frequently used contain from 12 to 8 per cent. aluminium, and 88 to 92 per cent. copper, and have a golden appearance and the strength of steel. The breaking load in tons per square inch varies from 44 to 39 with an average elongation of 9 per cent., and 38 to 34 tons per square inch with an average elongation of 21 per cent. They have high elastic limit and transverse strengths.

Where forgings or stampings are required, four classes of bronze are recommended, containing respectively 10, 7½, 5, and 2½ per cent. aluminium, the rest being copper. The specific gravities vary from 7·6 to 8·3, the tensile strength varies in castings from 30 to 20 tons per square inch, and the elongation varies from 22 to 40 per cent.

Uses of Pure Aluminium.—The uses of aluminium are very numerous. Probably the widest field is still in the purification of steel and iron. It appeals to the public as a material for constructing cooking utensils. It is not brittle like cast iron, nor does it rust like tinplate. It is used for internal fittings for ships, instead of wood, for motor car parts, and boiling pans for confectionery. The Admiralty employ it, and on the Continent soldiers are equipped with it when possible. It is used in a modified form of lithography, as a substitute for solenhofen. We have seen that with the increasing price of copper, aluminium is being used largely for conductors of electricity. It can be used for roofing houses. There is no reason why it should not be used to replace the present heavy bronze coinage. It wears beautifully bright and clean, and is sufficiently hard for this purpose.

[A large number of specimens—cooking utensils, wire, &c.—were exhibited by the British Aluminium Company, Limited, and cooking utensils and cups by Messrs. Braby, and a series of minerals by Messrs. Edward Davis and Co.]

DISCUSSION.

Mr. W. G. **Kirkaldy** said he had tested a number of specimens of aluminium, but, unfortunately, too often their compositions had been kept secret, so that he had not learnt as much from his experiments as he would have done if he had had access to all the particulars. He had similarly examined a number of different solders, the composition of which had also been kept secret. If he had known the compositions in both cases the experiments would have been much more instructive. Professor Wilson's remarks on solder were of especial interest, because he always found it difficult to make a proper joint.

Mr. **Nicol Brown** said it appeared to him that in the future there would probably be a good deal of competition between copper and aluminium, although until within the last few weeks aluminium had not competed with copper in price. At present only 1 ton of aluminium is produced to over 100 tons of copper. In considering the possibility of aluminium competing with copper for electrical purposes, from a commercial point of view there were three factors to be taken into account: (1) Relative conductivities; (2) relative weights; (3) relative prices. Taking the conductivity of aluminium as approximately 60 per cent. that of copper, and the ratio of the weights as approximately 1 to 3·3, it followed that the prices would be on a parity when the price of copper was about 50 per cent. that of the aluminium, or in other words, when the prices were as 2 to 1. As to the actual price of aluminium, taking the figures for it in the *Society of Arts Journal*, April 27th, 1900, which he had endeavoured to examine and check from other sources, and which he found may be taken as fairly representative, the following were the prices from early years up to the present time:—

Year.	Price per ton (2,240 lbs.).
1854	£122,173
1856	61,086
1859	17,658
1864	3,556
1889	3,256
1891	812
1892	495
1894	187
1896	163
1899	145
1900	145
1901	145
1901 (December)	130

The enormous reduction in the price of aluminium was striking, and ought to give ample encouragement to those who are working in this direction. The price at the present time for electrolytic copper was £71 per ton, which would be equal to £142 per ton for aluminium. The present price of aluminium was £130, so that it was slightly lower than copper at the moment. It was very well known that copper is much lower at present than it has been for about two years past. An improvement in processes will no doubt be going on in aluminium, and low grade bauxites, which at present it would not pay to work, may be profitably treated in the future. In this connection he would point out that we do not appear to have any definite information about the world's deposits of bauxite, and it seemed as if they were far from numerous. Unless aluminium can be extracted from other minerals than bauxite, it would appear that at no distant date a shortness would take place, as there is now a shortness of copper ore.

Mr. F. W. **Fletcher** thought the fact that certain aluminium alloy wires broke after being suspended for a certain period might be due to molecular change rather than mechanical strain. If copper, zinc, antimony, or brass alloys were left for a certain length of time without any tension they became brittle, and it was well known that a chandelier fell from the roof of the House of Commons, simply through molecular change going on in the brass of which it was made. It would be interesting to know the proportions of silver and aluminium necessary for the formation of a workable alloy, because he thought from his own experiments, it was possible to produce a silver alloy which would not show any serious discolouration in the presence of sulphur.

Mr. S. S. **Bromhead** asked if Professor Wilson could suggest a remedy for preventing aluminium spoons and forks from turning black. If the slightest quantity of vinegar came in contact with them, it produced a permanent black coating, and rendered articles, which otherwise were extremely suitable for domestic purposes, utterly useless. Some aluminium articles turned a leaden colour, which was no doubt the result of oxidation.

Mr. WALTER REID thought Professor Wilson had not attached sufficient importance to the chemical use of aluminium. When aluminium was obtainable at 1s. a lb., it could be used chemically for reducing purposes on a large scale. If aluminium could be obtained in a finely powdered form, it would be a very valuable substance in reducing organic compounds. In that connection, it would be worth while devoting some attention to experimenting with brittle alloys, which could be easily reduced to powder, and would be of very great importance, and open a very wide field for the use of aluminium. A great advantage in the use of aluminium was, that it was almost absolutely inert. If sodium, potassium, or magnesium were used for reducing, a substance was always obtained which might re-act upon the reduced material, but with aluminium that was not the case, the alumina produced being as neutral a subject as a chemist would wish to have. The use of aluminium for vessels to be used chemically, had been thrown back by impure material having been used in the first instance. Aluminium reduced by means of sodium had been used for chemical purposes, and had been a failure, the result being that aluminium generally had been stigmatised as unsuitable for resisting certain chemical agents. Now that practically pure aluminium was used quite different results were obtained. It would resist the action of chemicals which had previously been supposed to act upon it, especially resisting fatty acids. If chemical engineers, and those who produced chemical apparatus, would devote their attention to the production of aluminium vessels on a commercial scale, he believed they would meet with very great success, and the permanent uses of aluminium would be very largely increased.

The CHAIRMAN said he could just remember, as a boy, the introduction of aluminium, when it was thought worth while to present a piece, about the size of an ordinary round ruler, to the French Emperor, as a curio, on account of its striking property of extraordinary lightness. A great deal had been said about the tensile strength of alloys; and if Professor Wilson could state the tensile strength of commercial alnminium, it would be interesting to compare it with the effect of minute additions of copper and other metals, by which the tensile strength was raised to 20 and 40 thousand lbs. per square inch. The rivalry between copper and aluminium was an interesting study. When electricity became of commercial importance, copper had a wonderful boom and was produced with a purity quite unknown previously, and in great quantities. Aluminium, with a conductivity double that of copper, must prove in the future a great rival to copper if it could only be produced cheap enough. Copper being an ancient metal, unless a new departure was taken in its metallurgy, would probably increase in price, whereas aluminium being a new metal the tendency was to gradually cheapen it as time went on. The reader of the paper deserved especial thanks for his interesting series of experiments with 24 alloys of aluminium. It seemed to him that the most important use to which aluminium had yet been put was its addition to iron and steel castings, which enabled them to be handled with much greater ease than previously. Professor Wilson had not alluded to the extraordinary heat produced by burning aluminium, Sir W. Roberts-Austen having found it of great use in forming alloys, and in melting intractable metals. Aluminium, on account of its lightness, could be beneficially used for many purposes, especially in military and naval equipments. It was of great use, for instance, in the legs of cameras, binoculars, telescopes, and torpedo boata. The two things required were efficiency and lightness.

Professor WILSON, in reply, corroborated Mr. Kirkaldy's remarks with regard to the secrecy of the composition of solders. The composition of the solder used by the British Aluminium Company was stated in the paper and gave good results, although there were others of which he had no definite information. In reply to Mr. Brown's remarks, the first thing to be considered in comparing aluminium with copper was the basis upon which the comparison was to be made. If two wires—one of copper and one of aluminium—have the same length and the same electrical resistance, then they would transmit the same current with the same loss. Under these conditions the weight of aluminium and the weight of copper required would be as 1 to 2, and taking the figures he had quoted in his paper of £73 per ton for copper and £130 for aluminium, the comparison was slightly in favour of the aluminium. In castings, for instance, another basis of comparison should be adopted, the relative merits of aluminium, compared with any other metal, being considered volume for volume. In this instance it necessarily followed that, since copper was 3.37 times as heavy as aluminium, whenever aluminium costs less than 3.37 times copper it was cheaper volume for volume. The figures given by Mr. Brown showed that aluminium, from being practically a precious metal, had been so brought down in price that it could be used for articles of every day use. With regard to the exhaustion of the ore from which aluminium was obtained, it was well-known that aluminium was largely diffused throughout the crust of the earth, there being practically an inexhaustible supply. It was possible that the supply of bauxite, which was at present abundant, might ultimately be exhausted, but other ores, such as corundum, which contained about 50 per cent. of alumina, were available, and he was confident that long before the supply of bauxite was exhausted, processes would be evolved by which other ones could be successfully reduced. The industry at present was only in its infancy. In regard to Mr. Fletcher's remarks on the action of molecular change, and the Post Office experiment, 15 miles of $\frac{1}{8}$th inch wire were erected for telegraph purposes, but owing to a heavy storm, the wire broke. It was only fair to aluminium to state that some copper wires erected in the same district also broke at the same time. Since then uniformity in the manufacture of aluminium, had been greatly improved, which was proved by the excellent manner in which some wires erected at Larne had recently withstood a very severe storm. He exhibited a section of wire which had been hanging for four years at Foyers, the wire being as good now as on the day it was erected. He was inclined to think that the Post Office wires broke through want of uniformity of manufacture, and felt that when the uniformity was further improved, nothing would be heard of such slight failures. He was certain that the coming years would see a great advance in the manufacture of electrolytic aluminium on a large scale at a lower price. He was carrying out experiments with regard to molecular changes in aluminium wires, having 24 samples of wire aluminium alloys, suspended from the roof of King's College, but he had not had the opportunity of testing them over more than about nine months. At a later date he hoped to be able to give further information on the subject. With regard to Mr. Bromhead's question, if aluminium articles were cleaned with powders with which it was customary to clean silver they would tarnish and go black. By using "Monkey Brand" Soap in the cleaning of aluminium satisfactory results could always be relied upon. In the past a great deal of impure metal had been used in the manufacture of household utensils, but if pure aluminium utensils were obtained he did not think the purchaser would have cause to grumble. The lightness of the articles was very much in their favour. Colonel Crompton, on his return from South Africa stated that a boon had been conferred upon the army by the supply of aluminium articles which, on account of their lightness, could easily be transported. Mr. Reid, in referring to the chemical uses of aluminium, had raised a point of importance. It was well known that aluminium was a very strong reducing agent. If it was powdered and mixed with iron oxide, its affinity for oxygen was so great that the instant combustion was started at one point, it rushed throughout the whole mass. If it was cheap enough it would be of great use in that direction. At Taranaki, in New Zealand, there were about 50 miles of black sand on the sea-shore consisting of a wonderful deposit of iron oxide. If aluminium could be found there, and the process was not too expensive to work, the iron oxide might be reduced, and very cheap iron produced. In reply to the Chairman's question on the subject of tensile strength all the figures were given in the paper. He had not dealt with the question of the heat of combustion, because it was too big a subject. The Chairman's suggestions with regard to the beneficial use of aluminium in army equipment, telescopes, &c., had been fully borne out by the experience obtained in South Africa.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Professor Wilson for his paper.

Miscellaneous.

THE RAISIN INDUSTRY OF CALIFORNIA.

The average annual consumption of raisins in the United States for the past five years, has been about 80,000,000 pounds, or not far from one pound per head of population. Practically the total supply was produced in the United States, a supply which only a short time ago was met wholly by importation. No variety of native American grape has yet been developed suitable for the preparation of raisins. Over twenty-five years ago, choice varieties or vines of the raisin grape were introduced into California from Spain, the country from which almost the entire imports of raisins were derived. The industry did not at once assume commercial proportions, but it is notable that so early as 1885, the effects of increased production in California, began to be shown in a decrease of imports. In the fiscal year 1885-86, imports declined to 40,000,000 pounds from 54,000,000, only two years before. Production in California, on the other hand, began in that year to assume commercial proportions for the first time, and amounted to 9,000,000 pounds, against 2,000,000 in the previous year. The impetus given to the industry at this time was never relaxed; production increased by leaps and bounds until in 1895 the high record mark of 103,000,000 pounds was reached. Since 1895, the raisin production of California has declined, but this it is claimed has been due to adverse climatic conditions, and not to any decrease of interest in the industry. Exports of California raisins first became of sufficient importance to be separately stated in the official reports of United States Treasury Department in the fiscal year ended June 30, 1898. It is estimated by some authorities, that as many as 64,000 acres are devoted to the cultivation of the raisin grape, in the raisin-producing district of California. The city of Fresno, which is known throughout California as the "Raisin City," is a centre of a district which produces about two-thirds of the entire output of the State. Eight months of sunshine, and an abundance of water for irrigation, make of this one of the ideal grape-producing districts of the world.

Correspondence.

THE IDENTIFICATION OF WOOD.

I have read with much interest Mr. Herbert Stone's paper on the above subject, and would like to be permitted to make a few remarks as an addition to a discussion at which I was unable to be present.

First of all, a small personal matter. My "Manual of Indian Timbers" was several times referred to in very kind language, but both in Mr. Stone's paper, and in the remarks upon it by Dr. Schlich, there is some misapprehension regarding the responsibility of the descriptions of woods given in it. I feel sure that Dr. Schlich was not properly reported, and as, possibly, Mr. Stone had not read my introduction, I propose to give the full extract from page ix., written in November, 1881. The "writer" was, of course, myself.

"It is now necessary to explain how the descriptions of the woods were made. During the progress of the work of preparation of specimens in Calcutta, and afterwards at more leisure in Simla, the examination of the different woods and their description was made by a committee which consisted of—

"1. Dr. D. Brandis, F.R.S., C.I.E., Inspector General of Forests.

"2. Mr. J. S. Gamble, M.A., Assistant to the Inspector General of Forests.

"3. Mr. A. Smythies, B.A., Assistant Conservator of Forests, Central Provinces.

"The descriptions were usually dictated by Dr. Brandis, and written down by one of the others, generally Mr. Smythies, but the wood structure was examined by all three officers, and discussed before the description was finally passed. The whole was gone over three or four times, and in the later examinations, when the Committee was more accustomed to the differences of structure, the generic and family characters were discussed and drawn up. Some of the later received specimens, as well as those given in 'Addenda,' were described by the writer, but on the same plan and principle as was originally adopted by the Committee."

In referring to the chief works on the subject of the description of wood, and giving keys to enable them to be identified by their more easily-seen characters, Mr. Stone omitted to mention what is, in all probability, the most important, if not the earliest, book on the subject relating to European woods—the "Flore Forestière" of Mons. A. Mathieu, late Professor of Forestry at the Forest School at Nancy, France. The first edition of Professor Mathieu's work was published in 1858; it was followed by a second and third, the latter in 1877; the fourth edition, issued since Professor Mathieu's death, with complete revision, by his successor, Professor Fliche, appeared in 1897. In the "Flore Forestière" the wood descriptions are given with the genera, supplemented, where necessary, for the species; and at the end of the book is a detailed analytical key, which, in my opinion, is much better than the keys given by Professor Nördlinger and Professor Hartig. I can also recommend to Mr. Stone the excellent key to English (and some Indian) woods given in "Timber, and some of its Diseases," the very useful little work by Professor Marshall Ward, F.R.S.. of Cambridge, published in the "Nature Series."

I cannot agree, and I do not think that Indian botanists of any branch will agree, with Mr. Stone's complaint that "botanical explorers" omit from their descriptions, the useful products of the plants. Of course, in large general floras like the "Flora of Btitish India," it would be impossible to insert such things, but, with such exceptions, nearly every Indian botanist has given, perforce briefly, economic information. Roxburgh's "Flora Indica" is an excellent case in point. If Mr. Stone will study the "Dictionary of the Economic Products of India," by Dr. G. Watts, C.I.E., probably the most complete work of the kind prepared in any country in the world, he will see what Indian botanical explorers have done for the economic products of the country. In the "Manual of Indian Timbers" the wood specimens collected by Dr. Wallich were all examined and mentioned, as were the more recent collections of Sir D. Brandis, Mr. S. Kurz, Col. Ford, and others. In my new edition about to be isssued I have included also the collections of Sir J. D. Hooker, Mr. H. N. Ridley (Malay), and others, deposited at Kew; and one of my chief regrets is that the collection of the Brothers Schlagintweit could not also be included, because the names have been lost. What has been done in India, of course, I know more intimately, but I also know that Colonial British explorers have not deserved to be accused of neglect, and that the work done by the French and the Dutch has been as good as, indeed if anything, better than our own.

I think that in his remarks about Kew Dr. A. Henry was not quite just. I have been recently working in the Kew Museum and have been struck with the care taken to incorporate in it the woods sent by various correspondents. As I was not specially interested in Chinese woods I can say nothing about Dr. Henry's collections, but they are doubtless there ready for him or another to work up. The authorities at Kew were most kind in their help to me and were delighted that I should work in the museum; but it is abundantly clear to anybody who inquires into the matter that the present miserably inadequate and ill-paid Kew staff could not be expected to do wood-descriptions for explorers in addition to their own work. The Kew collections are national, and the herbarium and museum are maintained by the State not only for study by the staff of the establishment, but to be conveniently at the disposal of workers in general. There are, unfortunately, not many specialists in the study of woods, and it is very good news to those interested in the subject that Mr. Stone is going to devote his scientific life to it. His paper was very interesting, and I, for one, shall eagerly look forward to the results of his further work.

December 9th, 1901. J. S. GAMBLE.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock: –

DECEMBER 18.—"Range Finders." By PROF. GEORGE FORBES, F.R.S. SIR FREDERICK BRAMWELL, Bart., F.R.S., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

WILLIAM JAGO, F.C.S., F.I.C., "The Chemistry of Confectioners' Materials and Processes." Four Lectures. To be followed by practical demonstrations.

LECTURE IV.—DECEMBER 16.—Confectionery—Flavoured by fruit, cherries, currants, raisins, nuts, walnuts, almonds; preserved fruits, jams, essential oils, lemon, orange, almonds; fruit essences; vanilla—Their composition and properties.

SAMUEL RIDEAL, D.Sc., F.I.C., "The Sterilisation of Water." Four Lectures.
January 13, 20, 27, February 3.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 16... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) William Jago, "The Chemistry of Confectioners' Materials and Processes." (Lecture IV.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. H. N. Ridley, "The Economic Resources of the Straits Settlements and the Malay Peninsula."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. S. C. Kaines Smith, "The Marble Women."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor G. B. Howes, "Recent Work among the Mollusca."

TUESDAY, DEC. 17...Civil Engineers, 25, Great George-street, 8 p.m. Discussion on Mr. Bryan Donkin's paper, "Motive-power from Blast-Furnace Gases."

Statistical, 9, Adelphi-terrace, Strand, W.C. Mr. Reginald H. Hooker, "The Suspension of the Berlin Produce Exchange and its Effect on Corn Prices."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. J. S. Budgett, "The Structure of the Larval *Polypterus*." 2. Mr. L. A. Borradaile, "The Spawn and Young of a Polychæte Worm of the Genus *Marphysa*." 3. Dr. P. Chalmers Mitchell, "The Anatomy of Gruiform Birds, with Special Reference to the Correlation of Modifications."

WEDNESDAY, DEC. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Prof, George Forbes, "Range Finders."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Hon. F. A. Rollo Russell, "Further Observations and Conclusions in relation to Atmospheric Transparency." 2. Mr. W. S. Hoseason, "Remarkable Phosphorescent Phenomenon observed in the Persian Gulf, April 4th and 9th, 1901." 3. Captain R. A. Edwin, "The Mechanical Principle of Atmospheric Circulation."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 7¼ p.m. Mr. F. W. Watson Baker, Exhibition on "Development and Structure of Eyes, illustrated by micro-slides."

London Chamber of Commerce, Botolph-house, Eastcheap, E C., 2¼ p.m. Mr. R. Percy Sellon, "The Electrical Industry and Legislation: the Need of Revision."

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

THURSDAY, DEC. 19..Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. G. Elliot Smith, "The Brain of Recent and Fossil Lemurs." 2. Mr. F. Chapman, "The Ostracoda collected round the Funafesti." Exhibitions: 1. Prof. G. B. Howes, "A Gigantic Argulus from Japan, and a specimen dredged at the Cape." 2. Mr. J. E. S. Moore, "A New Polyzoon from Tanganyika." 3. Mr. Miller Christy, "An example of Whithes' Thrush (*Turdus varius*) shot near Clavering, Essex."

Chemical, Burlington-house, W., 8 p.m. 1. (*a*) Messrs. J. J. Dobbie and A. Lauder, "Corydaline: Part VII.—The Constitution of Corydaline." (*b*) "The Relation of Corydaline to Berberine: The Oxidation of Berberine with Nitric Acid." 2. Dr. W. H. Perkin, "The Magnetic Rotation of some Polyhydric Alcohols, Hexoses, and Disaccharoses." 3. Messrs. M. O. Forster and F. M. G. Micklethwait, "Stereoisomeric Halogen Derivatives of α-Benzoylcamphor." 4. Mr. G. Martin, "Is Argon an Elementary Substance?"

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. St. Chad Boscawen, "Recent Discoveries at Susa."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Arthur Wright's Paper, "Some Principles Underlying the Profitable Sale of Electricity."

Historical, St. Martin's Town-hall, Charing-cross-road, W.C., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. E. S. Barralet, "Synthol Developing Agent."

FRIDAY, DEC. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. A. M. Morgan, "Transmission Dynamometers."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. Mr. William Campbell, "The Microscopical Examination of the Alloys of Copper and Tin."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, DEC. 21...Irish Literary (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. W. Boyle, "Carleton."

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FRIDAY, DECEMBER 20, 1901.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRESIDENCY OF THE SOCIETY.

At the meeting of Council held on Monday, the 16th inst., the Chairman announced that H.R.H. the Prince of Wales had intimated his willingness to accept the Presidency of the Society of Arts, and that Sir Frederick Bramwell, Bart., F.R.S., who had been elected to the office on the accession of His Majesty, had resigned the Presidency.

On the motion of the CHAIRMAN, seconded by Sir JOHN EVANS, K.C.B., the immediate past Chairman of the Council, it was unanimously resolved, that His Royal Highness the Prince of Wales be elected President of the Society of Arts until the Annual Meeting of the Society on June 25th next.

On the motion of Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., seconded by Sir STEUART COLVIN BAYLEY, K.C.S.I., a vote of thanks was passed to Sir Frederick Bramwell, Bart., F.R.S., in acknowledgment of his services to the Society during the time he had occupied the Presidential Chair.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday afternoons, January 1 and 8, 1902, at 5 o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

The Lectures will be fully illustrated by experiments, photographs and lantern slides.

Members who desire tickets for the course are requested to apply for them at once, as no further issue can be made after a sufficient number of tickets to fill the room have been sent out.

Each member is entitled to a ticket admitting two children and an adult.

CANTOR LECTURES.

Mr. WILLIAM JAGO, F.C.S., delivered the fourth and last lecture of his course on "The Chemistry of Confectioners' Materials and Processes."

At the conclusion of the lecture, a demonstration of the manufacture of sweet confectionery was given by Messrs. Clarke, Nickolls and Coombs.

On the motion of the CHAIRMAN, a vote of thanks was passed to the lecturer.

The first lecture will be published in the next number of the *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Thursday, December 5, 1901: THE RIGHT HON. SIR HENRY DRUMMOND WOLFF, G.C.B. G.C.M.G., in the chair.

The paper read was—

THE NEW TRADE ROUTE TO PERSIA BY NUSHKI AND SISTĀN.

By EDWARD PENTON, B.A.

While I was visiting India in the winter of 1900-1, the Nushki-Sistán route was the subject of much discussion in the commercial world. Reports had been received from Captain Webb-Ware, the political agent at Chagai, whose efforts had done much for the safety of the actual route, and from Colonel Chenevix-Trench, the Consul-General at Meshed, telling of a large trade that was to be done in the eastern portion of Persia. As yet no commercial enterprise had been undertaken by any of the big firms, though the Chambers of Commerce of Bombay and Calcutta were anxious to learn all they could. Even the state of the actual route was unknown by most people. Baluchistán was considered an absolute desert, and the regions beyond it had been practically untouched by commercial enterprise. It was in order to see for myself what trade lay there that I undertook the journey from Quetta to Meshed. The trade of Persia had hitherto been controlled through three main entries, viz., Caucasia and Transcaspia in the North, and through the Persian Gulf in the South. The northern entries are, at present, entirely under the control of Russia. Goods enter from Resht, Astrabad, and Askabad, and the prohibitive duties imposed by the Russians annihilate all competition.

In early days, the northern route through Astrabad was the idea of the English merchant, Hanway, and we hear of him there in 1743, as well as the Scotchman, Mungo Graeme, who was murdered in that year. In those days Central Asia was in the hands of the Turkomans, but now Russia sits securely in Bokhara and Samarkand, and the defeat of the Tekke Turkomans in 1881, and the subsequent completion of the Transcaspian Railway by General Annenkoff, gave her entire control of the northern markets.

On the other hand, England has always been a predominant power in the Persian Gulf. Here her merchandise enters through Bandar Abbás and Bushire, and can command the south-western markets. If, however, the eastern markets required English goods, they had to be carried by caravan across the Dashtidut, a continuation of the great desert of Persia. This naturally places goods entering Persia from Askabad, which is only 150 miles road carriage to Meshed, in a predominant position in Khorasán, which has for centuries been one of the richest provinces of Persia. It is this country which the Nushki-Sistán route is to feed with Anglo-Indian merchandise.

Baluchistán, which marches with Persian territory, has, up till late years, been in the hands of warlike tribesmen. The work of the late Sir Robert Sandeman and others who have followed in his train has pacified the country, and it is now safe for the traveller.

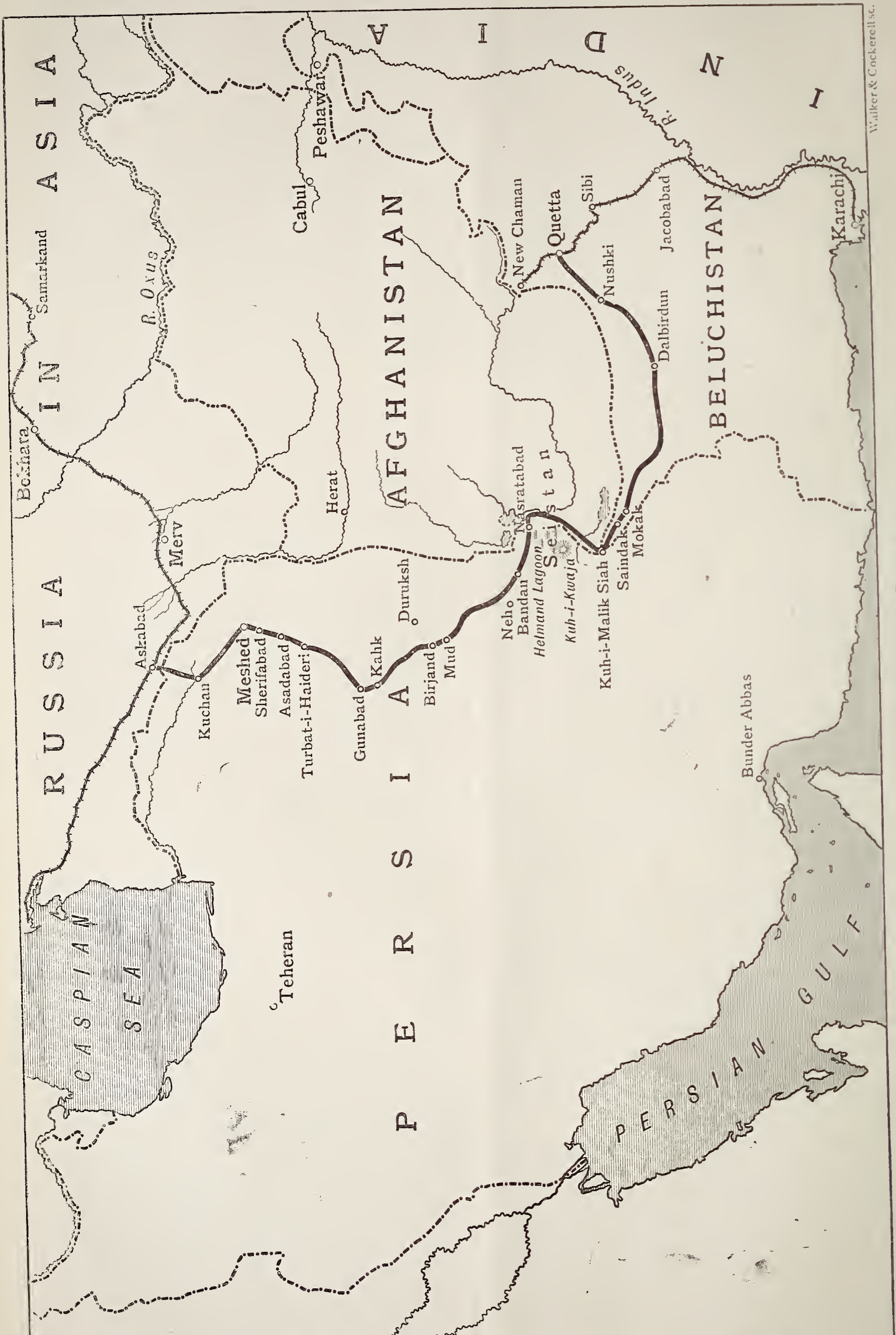
The Indian railways only reach as far as Quetta, which lies in the high plateau 6,000 feet above the level of the sea. Ninety-six miles distant from Quetta, at the foot of that plateau, is Nushki, the true starting-point of the route. Since my return to England, these ninety-six miles have been surveyed with a view to building a railway to Nushki, and a definite proposal is now before the Government of India. For the moment, however, all caravans must start from Quetta in order to be in communication with the railway. The start from Quetta has many disadvantages. In the first place, the township levies octroi. This difficulty has, however, been overcome by building a caravanserai for the reception of goods outside the town, and, as the station itself is outside the octroi limit, goods can pass between it and the serai duty free. Secondly, it is impossible for camels to remain there for any length of time. When large caravans, as is often the case, make a halt of any duration at Quetta the camels have either to be sent to Nushki or Sibi at the base of the plateau. Thirdly, Quetta itself, and the country, two, marches out of Quetta, are outside the jurisdiction of the Political Agent of Chagai who controls the remainder of the route as far as the frontier. This necessitates the Persian caravans, either starting from or arriving at Quetta, falling under the control of men who have already quite enough to do in their own districts without the additional worry of the Persian caravan leaders. My first experience of a Persian caravan illustrates the difficulties that arise from this system.

On my arrival at Quetta I decided to join the caravan of a Persian named Agha Mohammed, who was taking two Nawabs of Patna to make a pilgrimage at the shrine of the Imam Raza at Meshed, as well as Mr. Foley, who was journeying to Persia to represent the Indian Tea Association. The Nawabs had hired their camels in the bazaar, paying the rate of 80 rupees a camel to Birjand. The correct camel hire is 60 rupees to Birjand and 80 to Meshed, and it is most important that these rates should be strictly adhered to, as it is very necessary that the exact cost of carriage to Persia should be known. Agha Mohammed was very insistent that we should march with the caravan the whole way, and refused to allow us to journey separately. He delayed his start five weeks, and then despatched the caravan under the care of his brother Houssain Mohammed, while he waited for more goods which he expected from Karachi. No sooner were we safely out of Quetta than his brother proceeded to delay the caravan in order that Agha Mohammed might overtake us. For our own comfort we were forced to agree to pay 200 rupees, in addition to the camel hire, that we might take our own baggage and camels and proceed by ourselves. Fortunately we stipulated that the money should be paid in the presence of Captain Webb-Ware, whom we hoped to meet at Nushki. At Nushki, Houssain Mohammed endeavoured to withdraw from his bargain, probably to see if he could extort more money from us. This time we had power on our side, and Captain Webb-Ware employed very stern measures to enable us to get our camels.

My personal following consisted of three servants, a bearer, a cook, and a Baluchi sowar, named Jelal Khan, who acted in the capacity of guard, guide, and interpreter. Jelal Khan spoke Persian and Hindustani, and his services were absolutely invaluable, for in Baluchistán and Persia he obtained for me provisions and attention in places where my Indian servants would have been totally useless. I paid him 20 rupees a month, my cook 25 rupees a month, and my bearer 20 rupees, and stipulated that they should receive two months' pay to carry them over the return journey. There was no difficulty in finding servants, as many Mohammedans are only too glad of the chance of a cheap pilgrimage to Meshed. The march from Quetta to Nushki is made in seven stages by large caravans, but it can easily be accomplished by a smaller party in five. The march to Kishingi, the last stage, lay in the high plateau. From Kishingi, we made a rapid descent into Nushki. The first and second stages, namely, Girdi Talab and Chanak, are under the jurisdiction of Quetta; both possess small forts called by courtesy dak bungalows, with a room situated in a watch tower. In the courtyard below are the natives' quarters. On leaving Chanak we made a double march to Girdigah, as the intermediate stage, Bara Khand, provides nothing for the traveller except water. At Girdigah, we enter the jurisdiction of the political agent of Chagai, and here we first met with the local levies of Baluchis who guard the route. These men are worthy of description. They are not in the military or the police service, but are collected by the political agent and stationed at the thanas along the route. From these points of vantage they defend it from the attacks of robbers, who, though much reduced in numbers, still exist. The thanas are small forts surrounded by thick mud walls. They are posts of observation and defence. In the courtyard are a few rooms low and cramped, but invaluable as a protection against the mid-day sun. Supplies such as atta, ghi, and bhusa are stored in these and can be purchased by the passing caravan. At nearly all of them we could buy eggs, chickens, and sometimes mutton; milk, however, was seldom to be found.

Nushki itself is a small mud-built town at the base of the hills. It is connected with Quetta by a telegraph line, and one ventures to hope that, for the welfare of the trade, it will soon be connected by railway. In additon to a telegraph and post office there is a gaol, while a small stream serves to irrigate the few crops that are grown there. It has only been safe for the last two years, for before that the marauding Baluchis used regularly to fire into it. It is generally believed throughout India that the journey between Nushki and Sistán is an absolute desert. The more correct term would be an unfertile country, for to most minds the word desert invariably conjures up an image of the Sahara. For the whole of the way the camel grazing is excellent, and only on one occasion did I reach a place where there was not sufficient scrub to make a fire. The journey in no way presents the difficulty that is generally supposed, and I found that the thanas had been so well supplied that my natives could obtain the ordinary requirements of life more easily than in Persia. The country is inhabited by nomad tribes, and though it is possible for the traveller to cross long distances without seeing a human being, Captain Webb-Ware told me that he often had as many as two to three hundred visitors when he halted. During our journey between Nushki and Sistán, we marched at night on account of the heat, reaching our destination early in the morning, breakfasting about ten o'clock, and sleeping till it was time to start again. About six o'clock the caravan and servants were despatched. As soon as it had safely departed, we started, accompanied by Jelal Khan and a servant. The servant carried on his camel some food. Riding for about two hours at the pace of six miles an hour, we covered half our march, and sat down to our meal in the open. After the meal we slept, and between three and four o'clock we rode on again, reaching the next thana by sunrise.

Robat is the last British post, and the distance is accomplished in eighteen marches. These fall into three divisions, namely, five to Dalbandin, three to Merui, and ten to Robat. As far as Dalbandin the water supply is satisfactory, and at Dalbandin itself relays of camels can be obtained, and there are two native shops. The three stages to Merui have lately been changed on account of the water. On the present route sweet water is obtainable, though at the first stage it is about half a mile from the main road. Between Nushki and Dalbandin, bungalows are being erected at every stage. They are built of mud walls with large verandahs, and though totally unfurnished, prove excellent protection against the heat. From Dalbandin onwards the traveller has to depend on the accommodation of thanas except at Merui and Robat, where bungalows are already built. The present plan is to erect bungalows wherever sweet water is found, but as the route has not been definitely settled in



Walker & Cockerell sc.

Plan of Mr. Penton's Route.

every part, the building has only commenced at a few stages beyond Dalbandin. The journey from Merui to Pushtee Das, the first inhabited village in Persia, is the most difficult. The third and fifth stages, namely Kundi and Sahib Chah, have only temporary huts, and at both the water is absolutely undrinkable. At Sahib Chah it is so bad that even the camels will not touch it. At the sixth stage (Makak), the thanadar is Idoo, the Pahlwan, who was at one time a famous robber and the terror of the neighbourhood. I saw Idoo with Captain Webb-Ware at Nushki. He was on his way to visit Quetta for the first time. For years the British Government had placed a price of ten thousand rupees upon his head, but now he is a Government servant, and though still a little shy of entering what had been forbidden ground to him, he is an interesting character, and indicates to what good service the old marauding Baluchi has been turned by the efforts of the political officer. At the seventh stage, Saindak, there is a distilling apparatus, which acts admirably, and were these placed in some of the other thanas where the water is still doubtful excellent results would follow. The three marches between Saindak and Robat are all on the daman (slope) of the mountains which overlook the great desert of Afghanistán, and in the distance we could see the Gaod-i-Sirreh, as it gleamed in the sun. Robat is only half a march from the Kuh-i-Malik Sia which marks the point of junction of Baluchistán, Afghanistán, and Persia. The value of this post as a strategic position can hardly be over-estimated, but as yet there is no garrison, except the local levy and a Baboo, who looks after the post.

The distance between Robat and Pushtee Das is covered in five marches. During the first we skirted the base of the Kuh-i-Malik Sia, and, at our evening halt, we slept near the ziarat (shrine) of a saint, whom legend says was swallowed by the earth while discoursing to pilgrims. Hormak, where we halted the next morning, stands on the slope of the hills, and straight in front of us lay a desert plain. In the desert are thanas, under the control of the British Government, wherever there is sweet water. It had once been a fertile country, watered by the river Helmand, but the river has changed its course, and left the land barren and waterless. Deserted cities, which are still standing intact, testify to recent habitation. Between Pushtee Das and Nasratabád we crossed the country which the Helmand now waters. Innumerable dykes blocked our passage, and it is very difficult for camels to cross. Our caravan took two days to cover the remaining thirty miles, but we had the good fortune to borrow horses, and so we were not impeded by the water.

On May 27th we arrived at the British Consulate at Nasratabád about two o'clock in the afternoon. The British Consulate stands outside the town in a large compound. Within the compound is the Consul's house, quarters for the escort, stabling for the escort's horses, a storehouse and hospital, and a small mosque which has recently been built. Our present Consul is Major Benn. He is the second resident consul at Nasratabád. The Consulate was originally founded in the January of 1899 by Major Sykes, who was ordered from Isfahán to make a tour in Sistán, to raise the consular flag, and to report on the country. He met with violent opposition, not so much from the Governor, as from the chief Mullahs. His firmness, however, soon caused them to abandon their hostile attitude. From here Major Sykes went to Birjand and returned in the October of the same year to ascertain the state of affairs, and to establish Dr. Abbas Ali to carry on our political business. In 1901, Colonel Chenevix-Trench, on his way to take up the consul-generalship at Meshed, had orders to remain a month in Sistán in order to acquaint himself with the position of affairs. This month extended itself into twelve. The difficulties he met with were owing to opposition of various kinds. A repetition of these annoyances, which generally consisted in a series of plots to prevent further building of the Consulate, would only be wearisome, but they can easily be conceived by one who is acquainted with Eastern diplomacy. Colonel Chenevix-Trench, however, certainly gained a diplomatic victory, for he thoroughly established a Consulate before he left, and the British is now a far bigger establishment than the Russian. The presence of the Russian Consul in Sistán can only be intended to foil our interests, for probably no nation's diplomatists know better how to stir up sedition among the wild tribes such as the Baluchis. At the expiration of a year, Colonel Chenevix-Trench left for Meshed and was relieved by Major Benn. The latter was accompanied by his wife, who undertook the journey through Baluchistán and is the first British woman who has crossed the route, though Miss Sykes has told us in her "Through Persia on a Side-Saddle" how she accompanied her brother on the Perso-Baluchi Boundary Commission.

The town of Nasratabád itself is surrounded by a double wall. There is no real bazaar, the principal trade being carried on by a British subject named Seith Suleyman. His stock was varied and interesting as showing what goods were in demand at Persia. Whiteduck, innumerable cotton prints, tinned provisions, grenadine, plush, sparklets, boots, ladies' shoes, lamps, chandeliers, gaudy pictures (such as are seen in the poorer quarters of our great cities), scent-bottles, cigarettes, mats, carpets, a Russian-made cloth called Shikan Mahout, stationery of all kinds, looking-glasses, enamel ware, oilman's stores, medicines, cheap clocks, glass ware, teapots, padlocks, jewellery, cashmere work, furniture (Australian wood), carpets, hat-racks for camp, fancy match-boxes, are a few of the goods he sells. The Persians seemed so poor that I could hardly believe that there could be a demand for these articles, many of which were merely extravagancies. Seith Suleyman, however, assured me that he always got his money and that he was doing an excellent business. He has a branch shop in Birjand, and he was at the time of my stay preparing a caravan at Meshed. The British banking is all done at the Consulate. The merchant taking a caravan on the route pays his money into the treasury at Quetta, who, in their turn, give him a bill on the Consulate at Sistán. Should money be required at Birjand Seith Suleyman will issue a bill payable at his branch there. The Governor of Sistán, the Amir Hashmat-ul-mulk, lives in Nasratabád. He is under the authority of Meshed. I had an interview with him, but during our conversation we did not touch on any subject of vital interest. With a view to collecting the dues of goods entering Sistán a Customs Office had been instituted at Nasratabád. The Persian customs are collected by officers of Belgian nationality, though the regulations are issued from Teheran. The duty is 5 per cent. *ad valorem* on all goods, but a later edict charges this duty on the cost of carriage as well as the invoice value of the goods. In this we can see a determined blow to the new trade route, and by whose agency it has been dealt is hardly disguised when we remember the fact that Russia has a railway within 150 miles of a large bazaar on the north, while our nearest railway communication with Eastern Persia is thirty-five days' distance, or 595 miles from the frontier. In Persian history Sistán is famous as the native province of Rustem, the son of Zal, the fifth descendant of Jamshed. Persian legend has created him a demi-god, and the prodigies of valour which he performed for his country, and the pathetic story of the slaying of Sohrab, his son by an early amour, are among the most interesting legends of Persia. Yesdijird passed through the country when fleeing from the Mohammedan conquerors on his way to Merv, where he was ultimately murdered by a miller for the sake of his clothes.

After a fortnight's stay in Nasratabád I journeyed to Birjand alone, leaving Mr. Foley behind, as he intended to proceed more slowly in order to feel the pulse of the tea business in the country. From later information I heard that he stopped some time at Birjand, where the samples of his tea were favourably received by the merchants. He remained in Birjand some time entertaining the large merchants with tea and giving them samples. Later on he reported from Meshed that an enormous quantity of tea was used, and many of the merchants had agents in Bombay, where they bought Dehra Dun tea for about 5 annas a pound, his Assam tea being considered expensive. Every fourth or fifth shop he tells us sold tea either in the leaf or for drinking. The general opinion was that his Orange Pekoe was better tea than the expensive Java tea, and that in time it would oust it from the market. There seems to be no doubt that a considerable trade in tea might be done in Eastern Persia, and should any trading company decide to establish themselves in Birjand or Meshed, tea would doubtless be one of their chief articles of sale. He also carried samples of indigo, and found that the best quality of Indian indigo was greatly preferred by the Persians, owing to its pure dyeing qualities, which are so necessary in the manufacture of their carpets.

Though our way lay north-west of Nasratabád it was necessary first to march in a south-westerly direction to avoid the Naizar, or Helmand lagoon, which floods the country up to the foot of the Kuh-i-Khoja, a flat-topped hill, standing alone in the plain south-west of the town. From the Kuh-i-Khoja we marched to the north-west towards the hills which fringe the plain. To accomplish this march I despatched my servants with the baggage, and followed on myself the next day with a guide to join them on the other side of the lagoon. The lagoon is an inundation of a large reed brake, which is dry in winter. It is crossed in *tutins* (reed boats), shaped like Egyptian mummies, and propelled by poles. The people living on the lagoon are a race apart, and are little known to the outside world. Owing to the difficulty in crossing the water in summer, a new route is being made on the west side of the Palan Kuh, which branches off between Robat and Pushtee Das, avoiding Sistán and its dykes. The drinking water, however, has turned out so unsatisfactorily that the route is not yet in use. After joining my caravan, I marched to Bundan in the hills. From Bundan we decided to take post road, and cross another fifty or sixty miles of desert to Shusp. This route is not usually adopted by caravans, who prefer to march *viâ* Aliabad and Neh.

From Shusp, four marches lay between us and Birjand. The country was fertile round the villages, and several times I met with large troops of black-tented Baluchis, with their flocks. Our supplies were entirely dependent upon the goodwill of the villagers. Milk always was our greatest difficulty. At a village, named Ibrahimi, halfway between Shusp and Birjand, we were assured that no milk could be obtained, but a cup of tea and a few cigarettes soon induced the inhabitants to fetch their goats and supply us with all we wanted. During the whole of my journey, I found that the Persians were always willing to sell what it was no trouble to fetch, but it required much persuasion to make them take any trouble on our account.

The night before reaching Birjand, we halted at Mud, a fair-sized town, where the inhabitants lent us a house. The next morning we reached Birjand, to the south-west of which lies the Bakaran range, from which 500 karezes spring. Along the foot of the mountains lay, dotted here and there, cultivated patches luxuriant with trees. These are the seats of the nobles of Birjand, and are used by them in the hot weather. In the winter they take up their quarters in the town itself. After entering Birjand, I immediately made my way to the caravanserai in which Mohammed Ali Brothers carry on their business. The manager is Omirdin, who was at that time combining the duties of manager with those of agent to the British Government at Birjand. These duties are usually performed by an Indian doctor, who was established by Major Sykes. The chief duties are the management of the post and the helping of British subjects who are trading in the town. The British Government have a private Consular post between Nasratabád and Birjand, but at Birjand the letters for Meshed are handed over to the post of Persia. This system causes considerable delay, for the Persian post does not always fit in with the British. Of late years Birjand has been officially visited by four Consuls — three English and one Russian. Major Sykes, when Consul at Kerman, journeyed from Nasratabád to Birjand to establish our agent there. At the time of Major Sykes's visit hatred for the foreigner was a characteristic of the Birjandis, and it was customary in the mosques to pray against them and the Royal family of Persia. A little later Colonel Temple while on a journey from Meshed to Kain extended his march as far as Birjand, and had an interview with the Shankut-ul-mulk, the Governor of the province and brother of the Hashnut-ul-mulk. Colonel Chenevix-Trench, when on his way to relieve Colonel Temple as Consul-General at Meshed, halted here for ten days, and M. Miller, the Russian Consul, while journeying south to establish his Consulate in Sistán, stopped here a month to gain information for Russian traders. An attempt has also been made by the Russians to start a quarantine post, but owing to the insistence of the English objections it has been withdrawn. Birjand itself, as the depôt for Western Afghanistán, is an important factor in the commerce of Eastern Persia.

Before the Nushki-Sistán route was available, the channel by which Anglo-Indian merchandise passed into the country, was the caravan route from Bandar Abbás. Caravans used to journey to Bandar Abbás carrying with them the produce of the country, and bringing back the merchandise which was brought by the boats of the British India Company up the Persian Gulf. I found more English merchandise in the bazaar than I had anticipated, for I expected that as Meshed is much nearer than Bandar Abbás, Russia would have the monopoly of the trade. The English cotton prints bore the marks of well-known Bombay and Karachi houses, and though more expensive, seemed to be preferred at any rate by the wealthier classes. The cheaper articles are, however, supplied by Russia, Russian cotton print being sold at a kran (4d.) a yard and a year's credit given. Loaf sugar, owing to the bounty, is practically a Russian monopoly, Indian standing very little chance; while the tea for the most part was grown in Java and exported by Japan. Mohammed Ali Brothers stocked almost the same list of goods as in Nasratabád. Near Birjand is a carpet factory at Duruksh. I purchased two of these carpets from a merchant selling them on commission, for I had not time to visit the factory which was 40 miles distant from the town. Besides the merchants there was a large industrial population comprising fruit sellers, metal workers, potters, shoemakers, tailors, and hatters. The metal is all imported as the Shankut-ul-mulk has given no encouragement to the development of the local resources. These have not been worked for years, though an Afghan coppersmith told me that in the mountains not far off were copper mines four farsakhs (16 miles) in length.

Opium is the curse of the country. Omirdin told me that 75 per cent. of the men and 50 per cent. of the women are opium smokers. While wandering through the town I saw many of the shops were closed for no apparent reason. On asking why this was so, Omirdin informed me that the proprietors were away, because they had been smoking too much opium the night before. The sanitary condition of the town is hardly to be described. A system of drainage is absolutely unknown. As one enters the town one passes through a graveyard, which is situated high on the hills, so that a stream can easily pass throught it. In the caravanserai in which I was quartered there was a second court used as a slaughter-house. The stench issuing from this Augean stable was appalling. Every man paves the street opposite his own shop as he likes. The prisoners are chained at the corners of the streets at the Shankut-ul-mulk's pleasure, and depend for their food on the charity of the passer-by. The only responsibility which the Government took was the providing of the chains. Some of these were cruelly heavy. Prisoners who had committed lesser offences were placed in the stocks. The Persians of Birjand were the best-dressed men that I saw during the whole of my journey, and a much finer type than the men I met in Meshed and the North. They all wore long kaftans, or dressing-gowns, showing an opening in the front deeper than our morning dress, and less than our evening. The under-garment among the better classes was generally white; among the lower, blue; and while the better class wore a compact turban, the lower preferred a felt cap in the shape of a dome. Green, black, and brown were usually worn, and the dark brown *kaftan* of Birjand was one of the richest colours I have ever seen. The lower classes were universally clad in blue. Red is tabooed as being the sign of royalty, and also the colour of the executioner.

Outside the town the labourers were gathering in the harvest. The fields were busy with workers and gleaners. In some places the oxen were treading out the corn, while the donkey was used as the beast of burden. A swarm of locusts were also busy, and seemed to be reaping a larger harvest than the people. Cucumber, cotton, and barley were the principal productions of the country.

On leaving Birjand we crossed the Gudar-i-khabisi Pass and for three marches continued on the west of the hills which separate the Kain plateau from the Lut. At Mohammedabad we left the Lut and turned through the hills into the most fertile country I had yet seen. From Mohammedabad to Dasht-i-Piaz, a distance of 40 miles, we passed the villages of Nerau and Dehisk, both full of orchards rich with fruit. From Dasht-i-Piaz we crossed a mountain pass to Kakh, the shrine of the Sultan Mohammed, brother of the Iman Raza. As we stood on the hills we looked down on the shrine with its beautiful blue dome standing on one side of a dry river, while on the other side, the town with its fertile orchards overhang the banks. Between Kakh and Gunábad lay another barren plain. Round Gunábad there was a small knot of towns, of which Jumain is the most important. At Amroni we hired donkeys to supply the place of a horse incapacitated by sore back. In our next march we crossed a desert extending for 32 miles and reached Khairabad, a small village. There were only three watering places in the desert, and it was reputed to be infested with robbers. We marched through it under cover of a sand-storm, which lasted for five hours. From Khairabad Jelal Khan and I left the rest of the servants, intending to march on to Meshed alone, and let them follow with the heavy baggage. We reached Turbat-i-Haideri late at night. Before entering the town we marched down a long road extending for a mile with orchards on each side. Turbat-i-Haideri has a Customs Office and a Quarantine Post, and is also one of the strongholds of Russian power. In the caravanserai I first saw the flood of pilgrims *en route* for Meshed. At first I could not find a room vacant, and the man in charge of the serai wished me to sleep in one of the arches outside. This I declined to do, and an empty room was soon discovered. The motley crowd of pilgrims were an interesting study. Persians from the north, Persians from the south, Afghans, Baluchis. The *Saids*, or the descendants of the prophet, were easily distinguished by their black turbans, and were in number as the sand on the sea-shore. As we left Turbat-i-Haideri next morning a *Said* mounted on a little white donkey, which easily kept pace with our ponies, joined us and accompanied us for the rest of the journey. Robat-i-Safed was our next halt, and as we started rather later in the morning than the rest of the inmates of the serai I had a good chance of again observing the pilgrims. It was a repetition of Chaucer and his "Canterbury Tales." For the first three-quarters of an hour the road was crowded with men, some on donkeys and some on mules; a few rode camels, while the poorest tramped on foot. Among the crowd were many veiled figures of women, who were on their way to pay their devotion at the shrine. At noon we arrived at Sharifabád, and saw the first telegraph line I had seen since leaving Nushki. About three o'clock in the afternoon from the hills above we saw the glittering dome of Meshed, and at seven o'clock in the evening reached the town. It was necessary to make a detour to arrive at the right gate, so I did not reach the British Consulate till about 8 o'clock that evening, when I was warmly welcomed by Colonel Chenevix-Trench and his secretary,

Meshed is the shrine of the Iman Raza, the eighth Iman in descent from Ali. He was poisoned by Mamun, the son of Haroun-el-Raschid, the famous Caliph of the *Arabian Nights*. Mamun himself is buried near the Iman, but his tomb is entirely overshadowed by the fame of that of his victim, which owes its importance to being the principal Shiah shrine in Persian soil, the only other one being Kum, the shrine of the Iman's sister. It has always been a bitter pill for the Shiahs that the burial place of Ali is under Turkish (Sunni) rule. The shrine of the Iman constitutes *Bust*. This means that it is a refuge for criminals and may be compared to the cities of refuge in ancient Palestine. A criminal within the limits of *Bust* is no longer under the civil jurisdiction, and can only be arrested with the consent or the aid of the shrine authorities. The criminal in *Bust* is tried before the Governor of the shrine, who proclaims his innocence on receipt of a sufficient fee. This innocence is proclaimed to the civil authorities, and the fugitive is henceforth a free man.

Another institution of Meshed is the Sigha marriage. This is a temporary marriage lasting sometimes for a month, sometimes for a long term of years, and is another method of putting money into the pockets of the Mullahs. When the pilgrim arrives at Meshed without his wife, a temporary marriage is arranged through the agency of the Mullahs. The pilgrim is introduced to a lady, and they contract to live together as man and wife for a certain time, and at the expiration of that time the temporary husband pays a sum fixed beforehand. These wives cannot be divorced, and never take the position of the true wife, but as there is a certainty of provision at the termination of the contract, many women in Persia prefer to be married by the Sigha method, so that though they have no standing, they have no possibility of becoming destitute.

An attempt is now being made to bring the shrine under the same rule as Khorasán. The late Governor of Khorasán was both governor of the shrine and town, but on his death, the offices were again separated. No European is allowed to enter the shrine, and the nearest approach that I had, was the great barriers in the bazaar which divided *Bust* from the rest of the city. The large dome of the shrine is of blue tiles, and the two minarets have golden cupolas. In the town of Meshed, the main thoroughfare is called the Bala Kiaban. It is a broad thoroughfare, down the middle of which runs a stream, enclosed by a wooden fence. Innumerable serais and tea houses line either side of the street, as well as the ordinary shops which, in this quarter, mostly deal in provisions. We often went into this street in the day time, but the most interesting conditions under which I saw it, was one night as Colonel Chevenix-Trench and I were returning from our evening ride. It was lighted entirely by Russian oil, and the night scene gave the impression more of a Continental town than an Eastern city. The tea shops were full of Persian soldiers, the streets were crowded with buyers and sellers and here and there a Dervish was howling out his prayer. The bazaar itself is roofed and is full of Russian goods. Lamps, furniture, ironmongery and piece goods, are cast into Meshed by the Transcaspian Railway to be again distributed among the smaller bazaars of Khorasán. This is not surprising, for the distance between Meshed and Askabad is only 150 miles, and at the latter place there is direct communication with Europe. In addition to these advantages, Russia gives such large bounties to her subjects in Persia, that they not only cover the cost of the freight into Persia, but leave a little profit for the merchant besides. They also guarantee against loss for three years. I visited two shops belonging to

Russian Armenians. They were not pleasing types, but were reputed to be sharp men of business. Their principal stock was piece-goods. The only British business interests are at present represented by a branch of the Imperial Bank of Persia, and a wool buyer for a large firm. From the abuse that has lately appeared in the Askabad newspaper, I have every reason to believe that we are rapidly gaining influence in the town. The Consulate General was instituted by General Maclean, and among the lists of Consul-Generals at Meshed, have been the late Mr. Ney Elias and Colonel Yate, who has recently given us a book on Khorasán. Till the opening of our present route our consuls were compelled to reach Meshed either through Russian territory, that is by the Transcaspian Railway, or over the Baku and Resht route, or by entering through the Persian Gulf, which entails a long and wearisome journey. Now that our consuls can journey to their offices by our own trade route, the situation at Meshed should not be so desperate as some people believe it to be.

I left Meshed in a victoria drawn by four horses harnessed abreast. My journey for the first two days took me along a flat sandy plain, past Chinaran to Kuchán, where we arrived on the second night. From here we crossed the hills, and on the third night halted at Persian Bagiah. Russian Bagiah has a Custom-house, and here my passport to Transcaspia, which had to be specially procured from the Russian Minister of War, was duly examined, and I entered Russian territory. At Askabad I took the train on the Transcaspian Railway, and in 22 hours reached Krasnovodsk on the Caspian Sea, whence I crossed to Baku, and thence journeyed to Moscow.

I have endeavoured to describe the condition and trade of Eastern Persia as I saw it, and to indicate to my hearers the part that the Nushki-Sistán route can play in the development of the resources for the good of India and England. Though we have a large trade in the Persian Gulf, the Russian trade with Eastern Persia is a wedge driven into our sphere of influence. With the institution of this route, we have a channel through which our goods can pass with ease into Eastern Persia. Should a railway be built as far as Robat, our frontier post, we shall be on an approximately equal position with the Russians at Askabad. Persia must assuredly be developed by the railways, as every country has been, and we ought to be in a position to take every advantage of these railways. Without a commercial stronghold in the East of Persia, we leave it open to Russia to obtain a concession for railways, and continue their Transcaspian Railway to Meshed, and thence down the western frontier of Afghanistán, whence it will cross the South of Persia to the sea. Such a move would be fatal to our interests were we to have no voice in the management. If, however, we place a firm foot at Robat, we shall be in a position to demand a share in any railway concession that will be given to Russia, and this position will enable our trade to hold its own in Persia, at the same time retaining our friendly relations with our Northern neighbours. If Persia is, however, developed by Russia alone, if we grant inlets for Russian trade without obtaining a *quid pro quo*, our position in the East will assuredly be in danger.

DISCUSSION.

The CHAIRMAN said he felt that the reader of the paper had contributed, at any rate, one step towards the development of Persia, a question now very much before the public. There were many views on the means of carrying out that object, but he did not wish to raise any discussion on that point. Sir Henry Bulwer used to say, "Never discuss with an able man any subject in which he is interested, because you will never persuade him, and he, on the contrary, will set you down for life as a stupid man for having differed from him." Therefore, he would not subject himself to the application of that remark on the part of the many able gentlemen who were present that afternoon, and who knew so much on the subject of India and of Persia. But he thought they would all agree that there was nothing which would be so conducive to the prosperity of the Indian Empire and consequently of the British Empire as the means of securing constant peace in Persia. Great advances had been made by Russia in obtaining a hold on the markets of that country. It was impossible to blame Russia for fair commercial competition, and he only hoped that Great Britain might be enabled to enter into harmonious relations with her, so that there might be room for both in Persia, as there was in Asia generally. He recollected that in his youth one great question was the making of the Euphrates Valley railway, and Sir William Andrew devoted much of his time and ability to promote that route. Unfortunately that project had disappeared, and there was really no land route for England to Persia at all if the Germans succeeded in carrying out the railway for which they had the concession. Therefore, our only hope of obtaining a hold on Persia was by a route such as that sketched out by Mr. Penton, which he explored by his own enterprise and energy, by thus retaining our hold on the Persian Gulf, and taking care that in the South of Persia our interests were always regarded and maintained. It would be futile on the part of England to endeavour to stop other countries from sharing in the trade of that country. It was impossible to prevent public works being made if they were required, and if money was found to make them. Great Britain did much to oppose the Suez Canal, but ultimately that Canal was made, because it was not mechanically impossible, and because funds were found to construct it; and it had turned out more beneficial to us than to any other country. In the same kind of way, he thought we should not oppose the making of railways in Persia, where there was much land to be reclaimed, and large resources to be developed; but that we should take care in the construction of any lines of railway leading from the north of Persia to the Persian Gulf, or across Persia to the borders of Baluchistan, that we had a full share and considerable control over the making and the management of these lines when made. He believed the Government of Persia would assist in promoting the welfare of the country, and he had himself always considered that nothing could be more desirable than to make Persia a bulwark for us, not by military methods, but by establishing it as a large centre of commerce and industry. He did not see why Persia should not be a kind of Continental Belgium. Belgium was for many centuries the battle ground of Europe, but since the neutrality of that country had been secured by the larger Powers Belgium had become one of the leading nations in industry and commerce. He did not see why this country should not contribute in the same way, though, of course, he could not at present indicate the means, to the establishment in Persia of a neutral Power devoted entirely to trade and industry, the independence of which should be guaranteed by the greater countries that traded with her.

Colonel Sir THOMAS H. HOLDICH, R.E., K.C.I.E., C.B., observed that it was 20 years ago since he made his way to Sistán, which he did not reach by the same route as that so graphically described by Mr. Penton, but striking north from Nushki, to the Helmand, he passed down that narrow and fertile valley into Sistán, so that he had had the advantage of approaching it from a somewhat different point of view. The opinion he formed of Sistán, and the opinion he had retained since, was, that while Sistán might be used as a sort of outpost of the Indian frontier—an outpost, as it were, from which we might conveniently look over the hedge and see what our neighbours were doing—its value as a military or political position was somewhat open to question. Geographically Sistán was a sort of *cul de sac*. To the west of it there was nothing but a desert, far worse than any desert Mr. Penton had described. To the east there was another desert with which he was totally unacquainted, and with which he thought very few people had ever made acquaintance. A line drawn south of the boundary between Afghanistan and Baluchistán, and thence turning north, was, he believed, the only practicable route which ran through Sistán; consequently the geographical affinities of Sistán were with the north chiefly. That route, as well as the route that lay between Nushki and the Kuh-i-Malik Sia were liable to very serious interruption. The Helmand River flowing from the north-west, took a great bend northward as it turned towards Nasratabád, and ended north of that position in a series of gigantic lagoons. These occasionally overflowed, when a large body of water came down the Helmand and then the lagoons extended to the northwestward in a vast sea, and reaching southward became the source of a new river, which flowed in a channel called the Shelag, and doubled, as it were, on the Helmand. The Helmand River made a counter march to the left, bending round on itself, and emptied into the huge swamp to which Mr. Penton had referred as the Zirreh. That isolated the whole of Sistán in such a way that it could only be approached by one narrow isthmus immediately south of the Helmand, between the Helmand and the Gaod-i-Zirreh. That isthmus had been, unfortunately, cut off from us by the boundary between Afghanistan and Baluchistán, and, so far as he was aware, the present road marked on the map as leading into Sistán was liable to be completely cut in two by the flood. This, it appeared to him, was a distinct and serious disadvantage if any railway was contemplated in extension of that which he believed had already been sanctioned from Quetta to Nushki. The advantages of the Quetta and Nushki extension had been touched upon in the paper, and Mr. Penton had given one excellent reason for its construction, namely, that Nushki formed a far more convenient terminus for Khafilas from Sistán or from Kerman (which he regarded as a much more important position than Sistán) than Quetta. The establishment of a railway between Quetta and Nushki would certainly deal with the most difficult section of a not very difficult line, which might connect Quetta hereafter directly with Karachi on the south, and would turn the terrible difficulties which occurred periodically in the mountain railways which were called the Mushkat and the Harnai; and if it should so happen hereafter (as he thought it would happen) that Great Britain should see that the advantages outweighed the disadvantages of a direct connection between the Kushk post and Herat, and that the line should be carried from Herat to Kandahar, the whole system to the south would dovetail neatly and admirably into one great system. He looked upon that as the great railway system of the future in Asia now that the Siberian Railway was completed; but that subject, perhaps, was a little beyond the pale of the discussion.

Major P. MOLESWORTH SYKES, in listening to the very interesting paper, had been carried back to a period of two years ago when he first went to Sistán to found a Consulate, and to travel in Eastern Persia. What struck him was the immense progress that had been achieved since that date. When he first went to hoist the consular flag at Nasratabád, the capital of Sistán, there was nothing there; and now he had seen a photograph of a very comfortable consulate with a hospital, which meant a medical establishment and other conveniences. As to Birjand, Eastern Persia, and the country generally, he thought Mr. Penton had travelled over it at the time it was at its best, when the bushes were green, and the country did not look so very barren. But he himself was there at all seasons in the year, and there were few countries in the world more barren—at any rate, he never wished to see one more barren than that country was. Some of the audience might have been asking themselves why the route went two sides of a triangle. The answer to that was because the late Amir of Afghanistan practically built a Chinese wall round Afghanistan, and exacted such heavy dues, that the direct route could not be used. The direct route was obviously from the end of the railway at Chaman to Kandahar, from Kandahar to Herat, and from Herat to Meshed. The route depended on whether the policy of the Amir was maintained by his successor, and he thought it was an important point to recollect this fact in judging the importance of the trade route under discussion. At the same time, it was considered, that any man who made two blades of grass to grow where but one had grown before, was a benefactor. He, therefore, thought that the Government of India and Captain Webb-Ware, who had spent so many years in introducing the *Pax Britannica* into what was very much of a no man's land, a land that "loathes a law," as Tennyson wrote, were to be congratulated on the progress that had been made.

Sir Lepel H. Griffin, K.C.S.I., pointed out that the question of the Nushki route was not a new one, as when the Chairman was at Teheran the question was taken up, and General Sir Thomas Gordon was sent by Sir Henry Drummond Wolff to Calcutta to urge upon the Indian Government the advantages of that very line. They were not then prepared to take it up, but the importance of the matter had gradually been impressed upon them, and he thought it was a matter of congratulation that so interesting a subsidiary route was being opened up with so much apparent success. He had brought with him a letter he received a very short time ago from the exceedingly energetic Consul-General in Sistán, Colonel Chenevix-Trench, who, if anyone, was the man to make that route a success. In his letter Colonel Chenevix-Trench said, "The trade from Bunder Abbás will be insignificant compared with the trade which I am sure will be with Sistán. People here, and perhaps in Teheran, hardly recognise the paramount influence we have secured in Teheran or Birjand, or the keen interest being shown by the Persians, both merchants and others, in those parts." At the same time it should not be forgotten that when Meshed was reached it was, as Sir Thomas Holdich, who was the greatest living authority in this country on the matter, had pronounced, a *cul de sac*. With the Russian frontier such a very short distance north of Meshed, and the Kuchan and Meshed districts not being fertile or very largely populated, there would be very soon a limit to English merchandise entering Russian Central Asia. The Russian tariff was so exclusive that it was very difficult for English goods to enter Russia at all, and he did not think there was a very large demand for them in that part of Persia, which was very thinly peopled, and a country very difficult to live in, as he well knew to his cost. With regard to the whole question of routes and railways for opening up the Persian territory, it must not be forgotten that Great Britain's real entry into Persia, and the real centre of British influence and trade in Persia, was the Persian Gulf. During the last few months he had seen in the reviews and the papers many articles, written, no doubt, by men of great ability, which appeared to pooh-pooh the superiority and preponderance of Great Britain in the Gulf, which had been a cardinal point of British policy during the whole of the century. At a moment like the present, without raising any discussion of a disagreeable nature, and expressing, as he felt, the most friendly and cordial sentiments towards Russia, with whom he did not think this country had really any occasion to quarrel, he should like to say that the Persian Gulf was, after all, the key-note of the whole Persian question as far as England was concerned, and no articles in newspapers, and the influence of no clever men, should lead Englishmen to think that they could with safety give up that position, a position which would be of very little value from the trading point of view to other nations, but which would be strategically of great disadvantage to England if occupied by anyone but ourselves. He, therefore, in the presence of Sir Thomas Holdich, wished to state what he had said on a platform before, that Englishmen who desired really to understand the geography of that most interesting part of the world, on which the destinies of England some day would revolve, should study Sir Thomas Holdich's book "On the Borderland of India." He held that to be the best book ever written on the subject, and every Englishman of intelligence should study it.

Mr. H. F. B. Lynch said that ten years ago he was staying in Teheran, conferring with Sir Henry Drummond Wolff on the practical details of his scheme for opening up Southern Persia to British trade, and since that day, the British company with which he was connected had been engaged in putting that scheme into practical execution—he spoke of the trade route by the Karun river, which entered from the Gulf, and worked up to Teheran by the tableland. Those with whom he had been working, had laboured under many disadvantages and encountered many difficulties, and there was one difficulty they had never been able to remove, and that was, that Sir Henry Drummond Wolff was removed from the Legation at Teheran to the Embassy of Madrid. Sir Henry was moved at a most inconvenient moment, and his absence from Persia had been very severely felt by those who were interested in Persian affairs, because his imagination, resource, and instinctive knowledge of the workings of the Asiatic character enabled him to achieve success, where it baffled most of his predecessors. He did not know how many quite realised that the British Empire at the present time might be said to practically march with the frontiers of Persia. All the territory of Baluchistán had been coming under British influence, and was now practically part of the British Empire, and Baluchistan being contiguous with Persia, the latter country was now our immediate neighbour. Another fact, which few were in a position perhaps to realise, was how much had been done within recent years by individuals, following upon the delimitations of boundaries, to develop the country. Major Sykes, not at all aided by the Government, had been largely instrumental in securing the success of the Quetta-Nushki-Sistán route, and also in establishing on a firm basis the influence of Great Britain in the important centres of Yezd and Kerman. It had been his (Mr. Lynch's) privilege, or misfortune, within recent years, to compile bibliographies for the countries on the West of India, and he had been impressed by the number of Englishmen who were contributors to the opening up of these countries. There was only one complaint he had against his countrymen. No other nation would have allowed their Governments to throw away all these disinterested labours; and the openings indicated, scientific, commercial, and political, would have been followed up with zeal. But this country had allowed its Governments to throw away all the valuable material, and the honey collected by ourselves other nations were being permitted to enjoy. In any negotiations or dealings with Persia we had very clean hands, a thing which could not be said altogether of our great rival in the North. We once had a serious difference with Persia which developed into war, but we retired and did not annex an inch of Persian territory, so that he thought we might console ourselves with the fact that in our dealings with those sympathetic quick-witted Asiatics, the Englishman represented not the annexor or the ambitious, but the peaceful channel of commercial intercourse, and, it might be, the bulwark of their national life.

Mr. J. D. Rees, C.I.E., in propounding a series of questions which he wished Mr. Penton to answer, agreed with Sir Lepel Griffin that there was no question of animosity or feeling against Russia, and thought that anyone who had lived and travelled in Russia and Persia must have a friendly feeling for both countries. But that did not alter the fact that the Russians had made the Caspian a Russian lake, and we had to keep the Persian Gulf a British sea. The first question he asked was: What were Mr. Penton's views as to the prospects of Indian tea in Persia? When he himself was in Persia and Russia he was under the impression that the tea chiefly used there was Chinese, and he wished to know whether, as Mr. Penton suggested, Java tea, of which he knew nothing, had superseded it. The second question was: To what other indigo was the Indian indigo preferred, Mr. Penton said, "preferred" to something? Thirdly: Did Mr. Penton come across any robbers during his travels, for robbers were suggested? Twenty years ago, when he travelled through Kurdistán, the whole population was supposed to consist of robbers, but he never met with a more kindly, peaceful, and agreeable people than those robbers proved to be, and he gathered Mr. Penton had found the same thing along his route. The Persian Government was generally supposed to be no Government, and it was also believed that robberies were continually going on. Then a reference had been made to the Persians being poor, and he wished to ask whether Mr. Penton meant relatively poor or actually poor? He found them well clothed and fed. The headaches and absences in the morning seemed to him to be more often the result of the draughts of that capital wine of Shiraz than to the use of opium, which had not appeared to him one of "the curses of the country." It seemed to him they used opium fairly moderately, and, as in China, where he had also studied the question, opium smoking was not quite the curse of the country. Another question he should like to ask was whether there was any probability of the railway going to Robat? He understood that Persia was under an agreement with Russia to make no railways without her permission for a certain term of years, but he did not know if that was the case, or whether a railway to Robat was seriously proposed.

Mr. Penton, in reply, said that with regard to the prospects of Indian tea, Mr. Foley was making a report to the Bengal Chamber of Commerce which would no doubt be published in the commercial journals of this country. Unfortunately he himself was not an expert in indigo or tea, and most of the information in the paper was drawn from what Mr. Foley told him and from what he had since heard through the medium of the Press. He had heard through the Bengal Chamber that Mr. Foley's report would be soon published and that it would deal with the question in great detail. Java tea was to be seen in both the bazaars of Birjand and Meshed. As to robbers, Baluchistán had been in an extremely unsettled condition, but since the work of Captain Webb-Ware, the traveller who went with a fair following need apprehend no danger. There had been one or two attempts to rob people with small caravans in the desert between Amroni and Khairabad, and in the gorge this side of Robat. He happened to be travelling with a very small caravan with hardly any weapons and an assault was expected. Mr. Foley, who was travelling alone, saw a robber pointing a gun at him, but when he told the man to stop he did so. He thought he might qualify what he had said with regard to the people being poor, by saying seemingly poor, comparing them with well-to-do natives. Persians would purchase luxuries that a native of India would not think about. As to opium, what he said was mostly given on the information of Omirdin. With regard to what he had said about the railway to Robat, he merely expressed a hope.

The CHAIRMAN proposed a cordial vote of thanks to Mr. Penton for his interesting paper, and the resolution was unanimously adopted.

Sir GEORGE BIRDWOOD, K.C.I.E., said the members of the Indian Committee present felt that they owed a debt of gratitude to Sir Henry Drummond Wolff for presiding that afternoon. He was the Nestor of the Diplomatic Service, and had rendered his country the most distinguished services, not only in Persia and in Spain, but also in, and in connection with, Egypt; for it was Sir Henry Drummond Wolff who, with such conspicuous ability, defended in the House of Commons, the purchase, by Lord Beaconsfield, of the Suez Canal shares, and also in a series of brilliant letters which appeared on that occasion in *The Times*, with the signature of "Memnon." They were proud to have him in the room that evening, and their warmest thanks were indeed due to him. He would add, with reference to Mr. Penton's remark that, opium smoking was the curse of Sistán—that he could hardly believe that this remark was the result of personal observation. He had closely studied the subject for fifty years, and the result of his reading and research was, that save in the case of concomitant evil habits, and they were very evil in China, opium smoking was as harmless as blowing bubbles, or sucking one's thumb. It was simply a fashion of whiling away the time. In a country like Sistán the unco' godly attained this end by a severe addiction to the observances of religion, which, there, as elsewhere, greatly subserves self-complacency; but for the ungodly there was no resource but opium smoking, or miscellaneous murder, and the milder sort took to the opium pipe, which might as well be sucked empty for any harm the opium in it could do them.

Sir CHARLES STEVENS, K.C.S.I., said he was sure he was speaking the feelings of the whole audience when he said that the paper had been a most interesting one, and that it had given rise to an excellent discussion.

FIFTH ORDINARY MEETING.

Wednesday, December 18th, 1901; SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Brydges, Edward Egerton Hanson, M.A., 11, Stone-buildings, Lincoln's-inn, W.C.
Calkin, Percival, Messrs. R. Rivière and Son, 33, Heddon-street, W.
Carey, Frederic William, Stratford-sub-Castle, Salisbury.
Ewing, William, 45, Renfield-street, Glasgow.
Foat, William, 20, High-street, Aylesbury, Buckinghamshire.
Gallini, John Baptist, 143, Great Suffolk-street, Southwark, S.E.
Gordon, Henry King, Cumberwood, Dorchester.
Harris, Lord, G.C.S.I., G.C.I.E., Belmont, Faversham, Kent.
Newson, Frederick Walter, care of Shewan Tomes and Co., Shanghai, China.
Peter, James, Mertinga Tea Estate, Munshi Bazaar P.O., South Sylhet, India.

The following members were balloted for, and duly elected members of the Society:—

De Friese, Lafayette H., Broad-street-house, Old Broad-street, E.C., and 32, Liberty-street, New York, U.S.A.
Gibson, Robert, Limerick, Ireland.
Kendal, James Francis, 440, Camden-road, N.
Leer, Isaac Wayne von, Hotel Sanz, City of Mexico, Mexico.
Uhler, Philip Reese, LL.D., The Peabody Institute, Baltimore, Maryland, U.S.A.

The paper read was—

RANGE-FINDERS.

BY PROF. GEORGE FORBES, F.R.S.

Instruments for measuring the distance of an object by optical means, are required not only by military and naval men, but by surveyors, by travellers, by sportsmen, by the mercantile marine, and by others. For each purpose there are special requirements as to the accuracy, range, and portability of the instrument. The instrument which I have perfected is the most difficult. It is intended only for military use, and only for one arm of the service. A time may come when I may adapt it for other purposes, but in the form now shown, it is intended only for use with rifle fire. It is not suitable for long-range artillery, nor for the navy. The instrument before you looks simple enough, such as might be designed and completed in a month or two. But it has taken me ten years of intermittent, besides two years of incessant, work and experiment and trial and alteration to arrive at the present simple and effective type, suitable for a single arm of the service. I may say, however, that this infantry type is by far the most difficult, because, in addition to accuracy, extreme portability is such an essential feature. At the same time, the infantry are more in want of some addition to their present resources than anyone else, and the urgent want for such an instrument has been proclaimed and re-echoed by all our officers who have returned from the war in South Africa.

All methods of optically measuring the distance of an inaccessible object depend on using a base of known length, which must be measured on the ground, or else be part of the instrument. In the latter case the instrument can usually be worked by one man, who can find the distance without changing his position. This class of instruments is sometimes spoken of as short-base range-finders. Numerous patents for such instruments have been applied for; but the difficulties in the way of ensuring accuracy are so great that only one type has ever been perfected and generally used. The Barr and Stroud range-finder has been adopted by the navy with most satisfactory results, and this has proved the fact that a short base ($4\frac{1}{2}$ feet) is not inconsistent with accuracy. But the Barr and Stroud instrument is as unsuitable for use with infantry as the instrument before you is for naval use. For the use of infantry, where extreme probability, and accuracy, and suitability for ill-defined objects, such as men, bushes, rocks, &c., are essentials, there is no instrument in existence which has ever been put forward as fulfilling the conditions, except the simple folding range-finder which I have to bring to your notice. In spite of all the tentative patents, it is noteworthy that this is absolutely unique, as no other short-base infantry range-finder exists.

Let us devote two minutes to noting the means by which we can find the distance of an inaccessible object, which may be any distance, and suppose it is to the north of us. Let us measure a base on the ground, east and west, 100 yards long, driving in a peg in the ground at each end of the 100 yards base. Let us have a table or drawing-board placed level at each of these pegs. Now we take a sheet of paper, and draw a line, A B, one inch long, to represent 100 yards. Going to the drawing-table on the left, we pass a needle through the point, A, and so pin it flat and level on the table. Then we turn the paper round, until a ruler, resting against the needle and lying on the line, A B, points along our base. Then keeping the paper fixed, we turn the ruler until it points to the distant object, and we draw a line, with pencil, on the paper along the ruler. We then go to the table at the other end of the base, and fixing the paper with a needle through the point, B, to that table, we go through the same operation and draw another line pointing to the distant object, B. The intersection of the two lines and the line, A B, on the paper, form a map of the positions of the distant object and of our base, on the scale of 100 yards to one inch. If the intersection be ten inches from A or B, we know that the distant object is 10 × 100 = 1,000 yards from either end of our base.

It is quite clear, now, that if we have a short base, say 6 feet long, then if we can measure the angle between two lines drawn from the distant object, one to each end of our base, we can determine the distance of the object from the base. All range-finders are founded upon this principle.*

The longer the base the more accurately is the distance found. With a base of 100 yards and a theodolite at each end of it for measuring the angles, the distance can be found with more than the accuracy required for any purposes of warfare. But the theodolites and their stands are heavy, and the instruments delicate; calculations must be made, time is required for the operation, and meanwhile the observers are attracting the attention of the enemy, and are perhaps in danger. For all these reasons the theodolite method is seldom practical, and simpler instruments, more portable, direct reading, easily and quickly used, with as little exposure as possible of the men, have to be devised even at some sacrifice of accuracy, to replace the engineer's theodolite.

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* If we are using, as I do, a base of 2 yards, then the angle at 3,000 yards distance is 2'.17'',5, and at 2,940 yards distance it is 2'.20'',3. This 60 yards difference of distance, which is 2 per cent. of the distance measured, must be measurable on the range-finder for infantry use. So we must be able to measure the difference of angles or 2''.8, but the naked eye is generally assumed to be capable of perceiving 30''. So we require a magnifying power $\frac{30}{2 \cdot 8}$, or nearly 11 times, to reach the required accuracy. For this reason I have used a magnifying power of 12. But with stereoscopic vision a far smaller angle than 30'' can be perceived with the naked eye, and a power of 8 gives me all the accuracy I desire, besides giving better illumination and easier manipulation.

With these considerations in view, the Weldon range-finder and the Labbez telemeter and other pocket instruments were invented for use with a base that might be measured by pacing. These were followed by the mekometer, invented by Colonel Watkin, which has long been the standard range-finder used by our army for infantry and artillery. The base varies from 25 to 100 yards, and consists of a string wound upon a reel when out of use. The range-taker and his assistant, after consultation as to the object to be sighted, proceed to the two ends of the base. The range-taker has a reading instrument, and his assistant has a right angle instrument. The string being held taut, the assistant looks through his instrument and sees two pictures superposed, the object and the range-taker's instrument being both seen, one in each picture. He moves about until these are exactly superposed, and he tells the range-taker. If the range sought be that of a moving object, the right angle man must move about all the time to keep his two points superposed. The angle at the end of the base where the assistant is must now be a right angle, and the range-taker looking through his instrument, superposes the two pictures in the same way, not by moving about, but by turning a drumhead on his instrument, which measures the divergence of the angle at his end of the base from a right angle. He then reads off directly by the scale on the drumhead the distance of the object. Colonel Watkin invented a very neat drumhead and scale for doing this with the utmost facility. This beautiful instrument, though not so exact as a theodolite, can be made to work with all the accuracy that can possibly be required by choosing a long enough base. It appeared to me that besides having this instrument the effective power of an army might be increased by having an instrument which could be used by one man without changing his position, and, if necessary, under cover of a rock, a tree, or a wagon. It seemed that the necessity for consultation between the range-taker and his assistant, might at times lead to confusion and error. It seemed that the parading of two men over the ground, while our skirmishers were concealing themselves behind cover, might sometimes be objected to. I have learnt that all who have fought in South Africa, agree that these difficulties do arise, and that the accuracy of shooting would be at least doubled, if an instrument such I have to show you, were in general use.

Professor Piazzi Smyth tried to make a short, self-contained base telemeter for surveying, with a base of 60 inches, Colonel Clarke 72 inches, Otto Struve used a base of 73·5 inches, and Adie one of 36 inches. All of these were failures. I am pleased to have discovered, and to be able to exhibit here, one of the few Adie telemeters ever made. It may be taken as the germ of all later attempts. Its faults are well known, and it is to the elimination of these faults that all subsequent inventors of this class of instrument have devoted themselves. It consists essentially of four mirrors at 45° to the base, and a telescope in which two superposed pictures are seen of the distant object, one picture being seen by reflection from the two mirrors to the left in the diagram, the other picture being seen by reflection from the two mirrors to the right. Since the object is seen in a slightly different direction from the two ends of the base, the observer sees the object double in the telescope until he moves one of the mirrors so as not to lie at 45° to the base. The angle through which he turns it is double the angle between the two lines coming from the distant object to the base, and, as we saw before, this angle tells him the distance of the object.

The mirrors are supported on an arm, and their weight bends it. Even the sun's rays will distort it, and the angle we have to measure is so small, that the errors thus introduced destroy the accuracy of the instrument. The present Astronomer-Royal, Mr. Christie, used a screen for the sun's rays, and to this Messrs. Barr and Stroud added an arm so designed for strength, that it does not bend by its own weight. All this makes the instrument very heavy, and not at all suitable for infantry use.

In looking at the diagram of the {Barr and Stroud instrument, you see that the two images are seen with one eye, hence the distant object appears to be double until the micrometer arrangement (a very ingenious one, consisting of a moving prism) has been so moved as to make a coincidence of the two images, when the scale reading of the micrometer gives the distance directly. It would be out of place to describe to you all the ingenious contrivances. I want now to direct your attention to this process of making a coincidence, upon which the accuracy of this, and of most other attempted short-base range-finders, depends.

Now in naval work, for which the Barr and

Stroud instrument is made, a ship, or its mast or funnel is very sharp against the sky, and the coincidence can easily be made; but this method is almost valueless in the field. A bush, or a rock, or a man is an object so ill-defined, especially against certain backgrounds, that in attempting to make a coincidence, you may move one picture in the telescope over the other for a considerable angle, before you are sure that it is double. An officer who used such a thing in South Africa, said it was impossible, in most cases, to get any accuracy of coincidence, and deplored the fact that there were no steeples or masts on the veldt. Sir David Gill, of the Capetown Observatory, confirmed this, and Messrs. Barr and Stroud asserted that no range-finders could be invented to get over the difficulty.

The difficulty has been got over by Messrs. Carl Zeiss and by myself, who use stereoscopic vision. If you will look at the diagram of the Zeiss telemeter, you will see that it resembles the one we have just examined, in most particulars, but it has two eye-pieces used with the two eyes. In the two focal planes also are two photographs on glass of two scales, the marks on one bring at slightly different distances from the marks in the other. Each pair of marks has a distance, so many hundred metres, marked upon it, and a certain degree of convergence of the eyes is required to make any pair of marks appear single. The object aimed at also appears single with a certain muscular convergence of the eyes, and it is easy to pick out a pair of marks requiring the same convergence as the distant object, and you read off the number of hundred metres on that pair of marks directly. I will speak of the accuracy of stereoscopic vision presently. I now wish to say that if you are looking at an ill-defined object the two pictures leap together into one so soon as you concentrate your attention on them. This is true even if the object be out of focus or so feebly outlined as a cloud. It is the consequence of our spending our lives in working those eye-muscles so as to make two pictures of an object appear as one. No muscles of the body are more constantly trained than these, and however faint the object may be the coincidence effected is absolute and immoveable.

This physiological action is referred to by Sir John Herschel ("The Telescope," p. 118). In describing an arrangement of powerful telescopes for stereoscopic vision he says :—

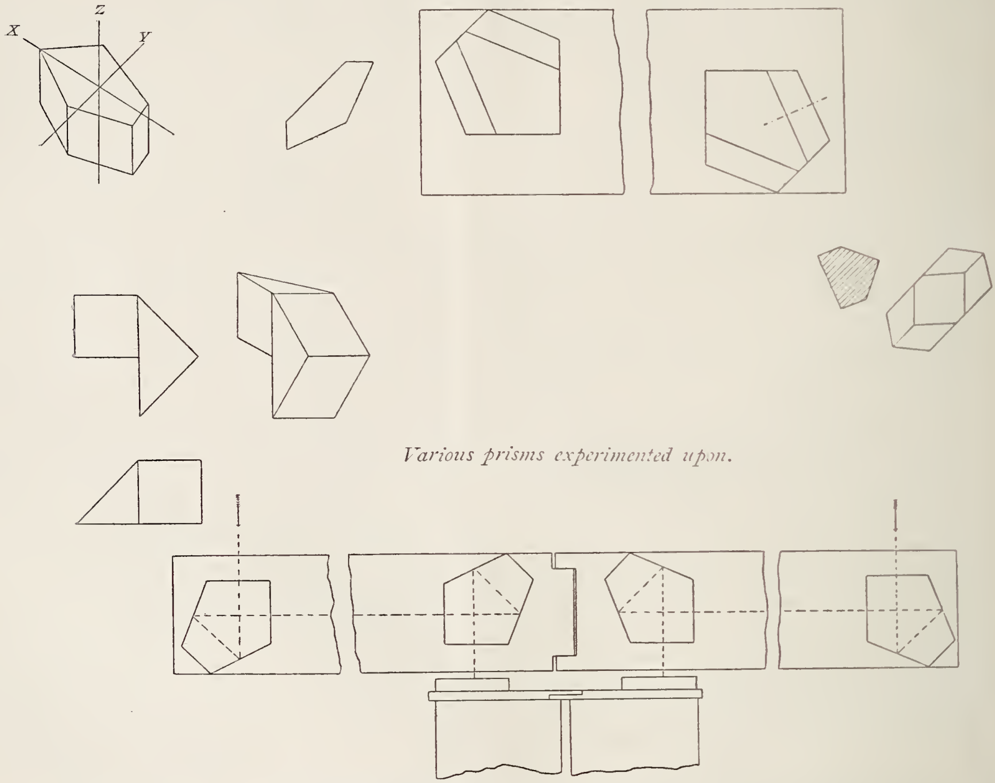
"When used for viewing near objects the mounting must admit of a slight convergence being given to the axes of the telescopes, to direct them at once to the same object. If this be not done the object is seen double; but so soon as the images are brought very near they suddenly spring together, even while some minute deviation still subsists, in a very singular and striking way; while the sensation changes at once from that of contemplating a picture to that of viewing a real object."

This remarkable training, by which our eye-muscles and our vision work automatically, hand-in-hand, is so remarkable that you will, I am sure, excuse me if make a further quotation from the article, "Microscope," in the *Encyclopedia Britannica* :—

"Comparing Wenham's device with those of Nachet and Riddell for obtaining stereoscopic effect with a binocular microscope, the author, after admitting that in the former the two images may be of different sizes and of unequal brightness, goes on to say: 'It is well known to those who have experimented upon the phenomena of stereoscopic vision (1) that a slight difference in the size of the two pictures is no bar to their perfect combination, and (2) that if one of the pictures be good, the full effect is given to the image, even though the other picture be faint and imperfect, provided that the outlines of the latter are sufficiently distinct to represent the perspective projection.' It might have been added that it is also well known that where both images are indistinct, as when a khaki-coloured coat is observed against a sandy background, or when both images are slightly out of focus, the two images still leap together by involuntary muscular action of the eyes, and the axes of the two eyes are held fixed at the true convergence required for making a single picture out of the two images of the object viewed. Dr. Pulfrid has correctly stated that not only do indistinctly defined objects which cannot be clearly pointed out in the ordinary way—a distant fold in the ground, irregular bush, or the skirt of a wood—but also such things as a cloud of smoke or dust—absolutely without contour—so long as they detach themselves from the background, can have their distance determined stereoscopically as well as the most distinct object."

We started with the Adie telemeter. We saw how Christie overcame the warping action of the sun by a screening tube, and how Barr and Stroud gave such rigidity to the base that it does not bend, and we have seen how coincidence may be obtained in the two images of any object by stereoscopic vision as used by Zeiss. But even after these improvements we are a long way from having the portable instrument required for infantry, which will not get out of order, and to obtain this we must adopt entirely different methods of getting over the difficulties, in order to reduce weight and to overcome the following troubles: (1) While single reflections are used at the ends of the base, it is very difficult to maintain their position accurately, and an error of 10 seconds deflects the ray of light through 20 seconds. (2) Where the base forms the telescope tube with the object glasses at its extremities, their displacement deflects the image in the focus. (3) To overcome the bending of the base to a few seconds of arc, it must be very strong and too heavy for portability. (4) Even so, with the Zeiss instrument, the zero of the instrument must be set before each observation, and differs for an object on the level, and another higher above it. (5) The setting of the instrument is very difficult.

FIG. 1.



Various prisms experimented upon.

PATH OF RAYS OF LIGHT THROUGH BASE—PRISMS TO BINOCULAR OF RANGE-FINDER.

I will now show how I have got over all these difficulties. (1) At each end of the base where the ray is to be reflected through a right angle, I do it by two reflections from two surfaces, absolutely fixed to each other at an angle of 45°. (2) I use stereoscopic vision and make the binocular telescope independent of the base. And (3) this enables me to have a hinge at the middle of the base which doubles its portability.

I find that the double reflection is best accomplished by using glass prisms. The diagrams show the path of the rays, and examples of the prisms are exhibited. Some of these have total internal reflection, others have silvered surfaces. The latter make the most convenient form of instrument, though they lose more light. With these prisms the ray of light is deflected through a right-angle, and a pair of prisms, if set fairly parallel sends the ray into the telescope quite parallel to the direction in which it entered the end of the base. In my instrument I could not allow an error of 2½ seconds of arc in the extent of the deflection of the ray in the plane of vision. To give so great an error, one of the prisms must be displaced with respect to the other through an angle of 18 minutes of arc. It is very easy to prevent such an error in the setting of the prisms.

If I used the base for telescope tubes as others have done, there could be no hinge in the middle, for if the hinge did not work with mathematical accuracy, the position of the focal image would change. With my arrangement, if the two halves of the base be not in a right line, still the rays entering the telescopes must remain parallel to the rays entering the extremities of the base, and it is the angle between these which measures the distance.

By the use of solid glass prisms for the double reflections, whose surfaces are immoveably related, and by fixing these firmly on a moderately rigid base, no adjustment of the base is required to ensure accuracy, unless it meets with a serious injury. The binocular, which is a separate instrument, and which contains the measuring devices, is the only part of the range-finder that requires occasionally testing, and this can be done with the utmost ease, as will be explained when I speak of the adjustments.

The diagrams here exhibited will assist in understanding the description which I now give.

The instrument consists of a folding aluminium base, 6 feet in length, and a field glass. The base is a square tube hinged at its middle, and folds up to 3 feet 6 inches. Each half has at each end a doubly reflecting prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular fixed to the base, in directions parallel to the original rays intercepted by the outer prisms. It is the measurement of the angle between these rays that tells the distance of the object looked at. This angle is measured by two vertical wires, one in each telescope, seen by the two eyes. One of the wires is fixed, the other is moved by a micrometer-screw until the two wires appear as one, while the object is seen distinctly. This gives the distance accurately to 2 per cent. even at 3,000 yards. But now stereoscopic vision comes in and gives far greater accuracy. The wire seems to stand out solid in space, and the slightest turn of the micrometer screw causes the wire to appear to be nearer or farther than the object looked at, and when the wire appears to be at exactly the same distance the micrometer reading gives the distance with an accuracy far greater than that attainable by observing the duplication of images on the retina.

I have spoken of wires in the focal planes of the binoculars, but I have given these up. I will tell you why. If I adjust the vertical wires crossing the field of view, until they seem to be at the distance of any object, say a tree, then the lower part of the wire cutting the foreground ought to be also at the distance of the tree. But common sense opposes this view, for the foreground is nearer than the tree. Thus the stereoscopic sense, if I may use the expression, believes itself deceived, and refuses to work so readily. To obviate this, I next used a line coming from the top vertically down to the centre of the field. This got over the difficulty entirely. Then I thought out a way of getting over another difficulty. We are not accustomed to see wires or lines in the sky or landscape, and we do not find the same tendency for them to " spring together," as Sir John Herschel describes it. The only real object I could think of with a point at its lowest part was a balloon with a tail-rope, the lower end of which is at the centre of the field. This has been a grand success, and the two balloons spring together even with observers who could never bring the lines to look like a pole at a fixed distance. Almost everyone can now get the stereoscopic effect easily.

There are not many men of science who have tested the accuracy of stereoscopic vision. All who have done so are aware that the stereoscope is the most accurate means of measuring an angle that we possess. Dr. Wolfe, of Heidelburg, has a stereoscopic comparator for detecting the motion of stars from photographs taken at different dates.

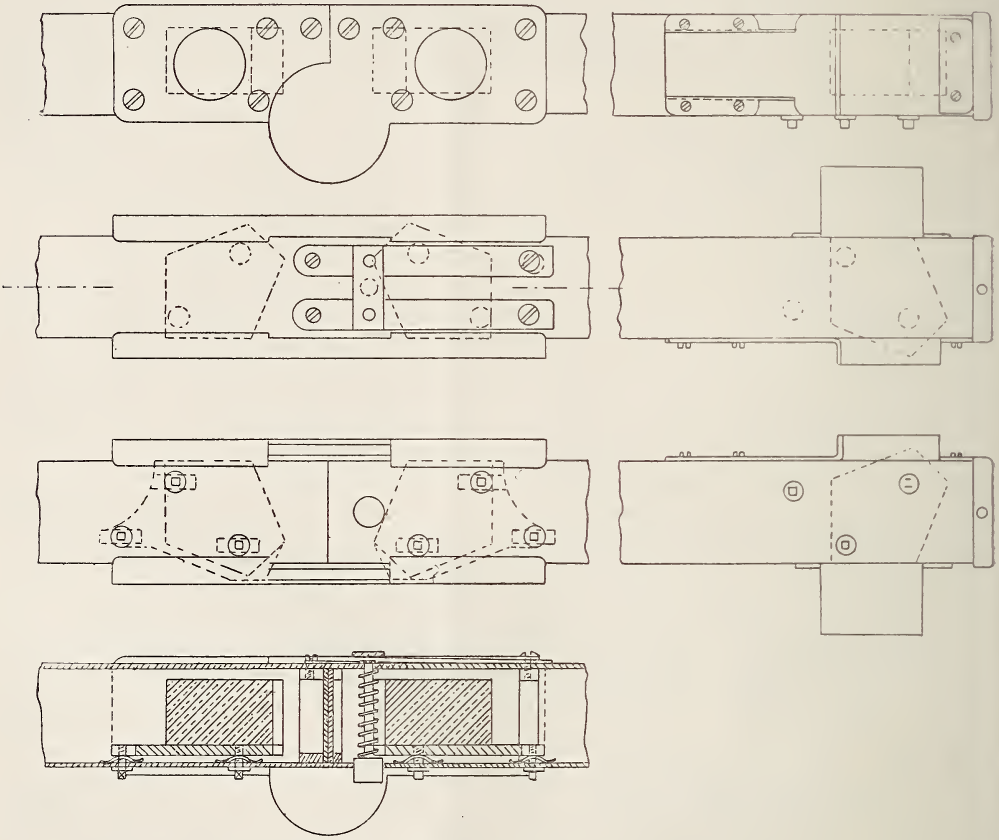
With this instrument, I have stereoscopically observed some of the stars lying in a direction at right angles to the sun's motion in space, by means of two photographs taken at an interval of four years. The nearer stars appear, with this gigantic base, to stand out distinctly nearer than the others in the stereoscope, although no micrometer, with the same magnifying power, could detect the parallax. It cannot be doubted that the naked eye can stereoscopically detect an angle of less than ten seconds.

The stereoscopic method has also this advantage, that the muscles of the eyes are being trained by us every hour of our lives, to make two pictures of an object appear as one. Hence when you look even at an ill-defined object, the muscles compel the two images to jump together.

I may mention that the wonderful accuracy of stereoscopic visions was first discovered by Professor Dove, of Berlin (Optische Studien, Berlin, 1859, pp. 26—36). As examples: he found that in a stereoscope, the eyes were able to detect the difference in size between a bronze and silver medal struck from the same die. On being examined, one with each eye, the resulting form appeared always to be curved, and not flat; also two impressions of printed matter from the same type, seldom failed to show some of the letters advancing in front of, or receding behind, the plane of the paper Professor Helmholtz, in his physiological optics, has emphasized the same fact.

I had a good illustration of it when describing my range-finder to a scientific audience. One speaker said he did not believe in the accuracy of stereoscopic vision, and gave the reason as follows:—"There is a blind in front of the window there with a cord. Holding my head steady, I tried to judge its distance from the window frame. I put it at 2 inches, but now I see that it is 6 inches distant." He was about 24 feet from the cord, and we may take 2½ inches as the distance between his eyes. The angle subtended was 28′·56″. But he thought the distance was 24 ft. 4 ins., the angle subtended being 28′·30″. So that in this first rough essay, he was able to measure the angle correctly to 26 seconds of arc, a very accurate estimate, instead of being inaccurate as he thought it was.

Fig. 2.



Top, Bottom, and Side Views of Range-finder Base.

I have had an excellent opportunity of testing the accuracy of stereoscopic vision. I adjust the micrometer screw until the balloon in the focal planes appears to be at the same distance as some clear object against the sky. The observation is repeated ten times and the maximum difference between any two of the ten readings amounts to less than one second of arc with a magnifying power of twelve. This means a maximum error of half a second, or six seconds with the naked eye. An accuracy to half a second is far closer than I have sought for, my limit being 2·8 seconds, to give 2 per cent. at 3,000 yards. Thus my instrument is five or six times more accurate by the use of steoroscopic vision than I require. I am, therefore, diminishing the magnifying power of the binoculars to eight instead of twelve, and even then I can confidently say that in the hands of an average man viewing an average object the range-finder will give the distance correct within 2 per cent. at 3,000 yards. I have put the instrument to the severest tests, and am ready to welcome the strictest trials of its accuracy. Moving figures, badly lighted objects, and even the targets at Bisley when they were dancing with mirage, have given distance measurements that exceeded the standards I had aimed at.

My base is 6 ft. long, and folds to 3 ft. 3 ins., and in carrying I find it best to strap it on the back. It weighs from 2½ to 3 lbs.

I have had many binoculars made, and at last have arrived at the beautiful solid scientific engineer's instrument which Messrs. Carl Zeiss, of Jena, have made from my designs, and which I now show you as the regulation type which I think ought to be adopted for infantry. Its optical qualities, used apart from the base, are superb. Used with the base, its indications are absolutely reliable, and it is strongly built and suitable for rough service. It weighs 2½ lbs.

The instrument can be used with only half the base, in which case the readings of distance must be halved. This is sometimes desirable in a gale. In this case you are viewing the object direct with one eye; this gives you a larger field and higher illumination, which qualities are at times useful.

This is not the place to describe the theory of the hinge, which few people have appreciated; nor the mathematical theory of the adjustments of the base. These are very easily made, owing to the manner of mounting the prisms each on three screws working against springs. These adjustments need never be touched when at work on the field. If one balloon appears higher than the other, a touch to one of the screws sets it right. The base cannot get out of adjustment, so as to give a wrong reading, unless it has met with a serious accident. Then the adjustment can be made in camp in half an hour.

It is necessary, however, to have a simple means of adjusting the micrometer scale of the binocular, as the zero may become displaced—or rather what we call the infinity point. The construction of my range-finder does this. The binocular, when attached to the base, can be moved up to view the object whose distance is required without using the base. The balloon is set to the same distance, and then the index, which is moveable on the scale, is set to the infinity point of the scale. The binocular is now lowered, and the distant object viewed through the base, and the balloon set to agree as to distances. The scale distance is read off, and 1-30th deducted (the base being 30 times the distance between the object glasses). This gives the true distance. If, now, we move the index till it points to this true distance without turning the micrometer, then the instrument is set, and will give directly the true distance of any other objects.

This range-finder can be used in a variety of positions. The more steadily it is held, the more accurate the result. A standing position is the least steady. When kneeling, using only half the base, the other half may be bent down at right angles, and so form a leg which serves as a rest on the ground. The most easy positien is sitting with the elbows resting on the knees. Another steady position is lying flat on the ground facing the object. In every one of these positions you can take advantage of cover. Since your eyes are virtually at the extremities of the base, you may stand, sit, kneel, or lie behind a tree, bush, rock, ant-hill, horse, comrade, or waggon; and you will not only be more able to work without sensation of danger, but your comrades who are seeking cover, will not abuse you for exposing yourself, and drawing on them the fire of the enemy.

Let us look now at the value of such an instrument. I have been assured that if my range-finder does all I claim for it, and if each company had one such instrument, then the effect of shooting would be doubled. One hundred men would then be doing the work, as fighting men, of two hundred, a gain, at £100 per annum, a soldier's cost to the country in peace, of £10,000 per annum per company. Supposing, then, that the instrument were to cost one-third of the 4½ foot-base instrument used in the navy, or £80 (and it is probably less), then for every £80 of capital spent, the army is receiving interest at the rate of £10,000 per annum.

I have had advice and encouragement from many whose authority no one could dispute. It is upon their advice that I fixed upon my standard of accuracy and other requirements, for an infantry range-finder. I have satisfied myself that the accuracy asked for is more than attained. But I eagerly asked for opinions as to general convenience from a soldier's point of view. These, I am glad to say, have all been favourable. Sir George Clarke, before he left Woolwich to take up his appointment as Governor of Victoria, was good enough to inspect its working, and gave me his opinion on these points. He wrote to me, "it seems to me that you have an excellent form, ideally portable, and extremely convenient." Then, after stating the degree of accuracy that he considers desirable, and saying that facility of learning to use it is essential, he adds, "another point is durability in the field. Here again, I do not think that an instrument can be made which will not require some special care in handling, and I think that your range-finder is perfectly satisfactory in this respect."

After receiving such expressions of opinion from such an authority, to whom I was a stranger, I felt it my duty to spare no effort to perfect the instrument made on these lines.

But the greatest encouragement I have received, which satisfied me that I was working on the lines required by those who are experiencing the want of such an instrument in actual warfare, came from Lord Kitchener at Pretoria, who, after seeing photographs of the instrument used in various attitudes, and after reading a detailed description, communicated with me, to express his interest in my range-finder, and his desire to have one in South Africa, and undertaking among his multitudinous duties, to see that the range-finder be thoroughly tested.

Such a test in actual warfare would be more severe and more crucial as to the special claims I make for this instrnment, and more satisfactory to all of us who desire that the army should be raised to the highest efficiency, than any tests that could be made at home. I am more than ready, I am anxious to submit my range-finder to this test, and have replied to Lord Kitchener, that I hope to make all arrangements immediately, to enable me to proceed to South Africa to assist him in testing the instrument in the way he has indicated, and I have arranged to start in a few weeks' time.

I have not attempted to decide how the range-finder shall be clothed and fitted up. I mean whether it should be covered with leather to look like a shop instrument, whether it should be in a leather case to carry on the back, or should be worn as a sword, &c., &c. I have produced, after showing my models of various dates to most competent authorities, a type which I am satisfied is the best that the sciences of optics and mechanics can give to fulfil all the requirements. I could give you greater accuracy at the sacrifice of portability, or greater portability at the sacrifice of durability in the field, or greater field of view and illumination at the cost of convenience in handling, or greater rapidity of working at the risk of making errors. But I cannot give you an instrument which meets all these requirements more fully, in proportion to their importance, than the range-finder which I humbly submit this evening to your notice.

DISCUSSION.

Major - General **Sterling** said he could state from his knowledge of many officers in South Africa that there was a great and growing demand for an accurate and rapid range-finder, which could be used without a shifting base and without the employment of a second man. No training in estimating distances in the English climate would enable men going to a completely different climate, such as South Africa, to acquire facility in estimating distances in that country. The rarity of the atmosphere was so great that the comparison was perfectly misleading.

Dr. **Common**, F.R.S., thought the accommodating power of the eye in bringing two objects so closely together was an argument against the use of the eye stereoscopically in determining distances. If the two objects leaped suddenly together it showed that they had not been brought together accurately; there was a margin which must admit of inaccuracy. He saw one of the instruments at Bisley during the year, and after a long time had been able to measure with it, but it gave him the impression that there would be a difficulty in getting the stereoscopic contact. There was nothing to choose between the Barr and Stroud, the Christie, and the Adie instruments optically, but the Barr and Stroud instrument owed its great power and accuracy to the care which had been spent in its manufacture. He heartily congratulated Professor Forbes on his instrument, which seemed admirably adapted for the purposes for which it was intended.

Mr. **Alexander Siemens** mentioned that the question of range-finders was solved by the late Dr. Werner Siemens, but not in the way described by Professor Forbes at the beginning of his paper. There were two observers with a given base line, the two apparatuses being connected electrically. There was an electrically worked pointer on the observer's instrument which always placed itself parallel to the second telescope, so that the assistant had simply to point his telescope to the object, the pointer on the chief observer's table being parallel to it, the intersection appearing the moment the telescopes were both pointed to the object. The instrument had the disadvantage that it was very heavy and required two observers, and the telescopes also were at a considerable distance. Professor Forbes had estimated that greater accuracy in finding the range would make shooting twice as good. From his experience of actual warfare, it was his opinion that while it was useful to know the range, much depended upon the soldier keeping cool and collected, taking his time in aiming, and not shooting too fast. Of course, his experience was obtained when soldiers were able to ascertain by the smoke from the guns where the enemy were; conditions which did not at present exist. The importance of range in new modern warfare could not be over-estimated when the ranges of guns had been so much increased. He thought Professor Forbes had taken too much credit by supposing that he could save half the number of soldiers; he did not think he would be able to save more than about 10 per cent.

Colonel **Allan Cunningham** said that one point of considerable importance to the holder of the instrument was that it did not really matter how the instrument was held; it need not be held horizontally or inclined at an angle, but might be held vertically. It would be also interesting to know whether the optical arrangements of the instrument ensured two angles being equal, a very great deal depending on that being so. It was also important to consider whether the observer's personality in any way affected the stereoscopic vision. Professor Forbes was to be congratulated on the simple and admirable manner in which he had overcome the difficulty of the true length of the base, a slight bending in the two legs not making much difference. Dealing with the practicability of the instrument, it was important to know whether the shaking, which such a portable instrument would naturally get in being carried about, would effect the accuracy of the parallelism of the lenses in either arm. If the instrument was dropped owing to a man stumbling, or from any other cause, would it be injured? It would also be interesting to know what the weight of the instrument was.

Professor **Forbes** said the base weighed from 2½ to 3 lbs., and the new type of binoculars also weighed about 2½ lbs., the total weight being 5 lbs.

Mr. J. H. **Agar-Baugh** suggested that Professor Forbes should use an ordinary short telescope instead of a prismatic glass, which had the disadvantage that it was very sensitive and could not be easily cleaned. The angle of the eye of the observer also might affect the accuracy of the range-finder. If magnalium was used for the base instead of aluminium, it would be lighter, stronger, and more rigid.

Mr. J. I. **Thornycroft**, F.R.S., said Professor Forbes had demonstrated that stereoscopic vision gave one power to measure when it was otherwise impossible to do so. He wished to comment upon how quickly the eyes adapted themselves to slight changes in the angle at which things appear. Whilst sitting in the room, he had been twisting his spectacles through a small angle, the effect of which was to interpose in effect a prism to each eye, the object viewed thus being distorted. But he had found that in about one second the eye accommodated itself to the change, so that a very short time only would be required for the eye to adjust itself to Professor Forbes' instrument, and errors would not arise from that cause. He wished Professor Forbes every success with his instrument.

Mr. **Newnham Browne** asked whether the continual use of the instrument produced any excessive fatigue of the eyes? On experimenting on a similar subject some years ago he found that where the eye was frequently concentrated upon two images formed in a different plane the irritation of the eye was very considerable.

Lieut-Col. T. V. **Wynn Phillips** thought there could be no question that a range-finder was badly needed in the army. The present mekometer, although excellent in its way, was a two-man instrument, which had the obvious disadvantage, that very often the two men were endeavouring to find the range of different objects. From the experience obtained in South Africa, the whole of the Service was agreed that a new range-finder was wanted, and the army had to thank Professor Forbes for the trouble and expense he had taken in perfecting his instrument. He was certain that the personal element played an important part in the use of the mekometer, many of the reports obtained from South Africa indicating that the men who had had charge of the instruments had not the remotest idea of their working. A one-man instrument which could be used easily would be much less liable to such errors, because anyone who had used a glass which gave a stereoscopic effect could not but appreciate its great value. He had used the Zeiss range-finder for weeks in suceession, and for four or five days in every week he obtained a correct range, but on the other days he could not obtain the stereoscopic effect. The arrangements of the prisms and the general construction of Professor Forbes' instrument was admirable, and he had not the slightest doubt that it could be made sufficiently rigid to keep the outer prisms accurate. There was no doubt also that it wonld bear a fair amount of rough usage, but a range-finder was essentially a scientific instrument and must be treated as such. Any instrument which had to measure two seconds of arc must be treated in a careful manner. He would like the reader of the paper to state whether those who had used his range-finder found any difficulty in getting the stereoscopic effect.

The **Chairman**, in dealing with the question of stereoscopic effect, said he had frequently amused himself by taking two separate stereoscopic slides and putting one end of one and one end of the other into the stereoscope at the same time. He found that first of all one eye appeared to dominate, and then the other, but after a second or two the eyes worked together and a confusion of the two slides was seen. It was very instructive to learn how the eyes would have their own way. He gathered that

Dr. Common thought there was a danger that two bodies might leap together in imagination, when they were not together. If a very thirsty man was employed as a taster of rare wines, his desire to drink would interfere with his discrimination. That, he believed, was the difficulty in Dr. Common's mind with regard to the stereoscopic view.

Professor FORBES, in reply, thanked the various speakers for confirming what he believed was the case, that there was a very great need for the instrument to which he had devoted so much time and trouble. With regard to the liability of the instrument to be injured, as a speaker very justly said, an instrument which was to measure two seconds of arc must be handled with some care. In the base itself, an an accuracy of eighteen minutes was dealt with, not two seconds of arc, a very large quantity to the maker of scientific instruments. When travelling, he usually tied the base to an umbrella, threw it into the rack, or put it against the side of the railway carriage; and although he had travelled some hundreds of miles with it no error had been caused. Unless a very visible injury was occasioned he was convinced that no error would occur. With the binoculars it was different, the greatest care being required to secure accuracy. It was essential that the zero or infinity point should read accurately. When the distance between the eyes of observers was changed, the arrangements of the binocular were entirely altered and had to be re-set. If the range-taker was shot, and another took his place, it was essential that he should be able to adjust his zero in the manner described in the paper, before he proceeded to take a range. If the base met with a serious injury, such as being kicked by a horse, and a great dent made in it, it could be put in thoroughly good working order again in half an hour. He did not think convergence of the eyes, or squinting, would interfere in the use of the instrument. He squinted himself to a very small extent, but he had found no difficulty in making two objects appear as one. It had been suggested that a telescope should be substituted for a prismatic binocular. If any gentleman could produce a telescope as handy as his binocular, he should be only too delighted to try it, and, if successful, to use it, but he was sure some difficulty would be experienced. Very few people had any idea of the difficulty he had experienced in getting his binoculars made. There was not a manufacturer of binoculars in the country, so far as he had been able to find out, who was capable of making his instrument, and it had to be made in Germany. Considering the large number of binoculars required for the army, and hoping, as he did, that the Army would be furnished with his range-finders, he thought it was worth while for the War Office to take into consideration the question of manufacturing binoculars in the country. It was a great pity that the country was dependent on Germany for accurate work in such instruments. About fifty people had tried the instrument when wires were used, and after five or ten minutes training, they were all, with the exception of three, able to see the stereoscopic effect. It was curious that of the three who could not see it, two were men whom he thought were more certain than any of the others to see the effect. Since he had put in the balloons, he had not seen anyone who could not bring them stereoscopically together. He had improved the balloons by making them different, the left balloon having an L on it, and the right balloon an R; the user could then be certain that he was looking right. In reply to Dr. Common, he had no doubt that stereoscopic vision was accurate. The tests to be made would definitely decide the question. Mr. Siemens had called in question his statements in regard to the improvement there would be in shooting. He had simply taken the estimate given him by a large number of military men in South Africa, who had told him that if his instrument did what he claimed for it, the improvement in the shooting of the men would be at least doubled. That was also his own opinion. Having, like Mr. Siemens, seen a good deal of actual fighting, he was convinced that accuracy of range was a matter of the very greatest importance. In reply to Colonel Cunningham, the angles could not but be equal. He was certain he had the instrument which was wanted by the army, although if anyone could suggest improvements he should be only too delighted to consider them.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Professor Forbes for his paper.

Miscellaneous.

*CHEAPER RAILWAY FARES.**

On no subject is opinion so frequently and strongly expressed, both in private and in public, than on the need for cheaper railway fares. It cannot be contended that this is mere British grumbling, since, if it means anything at all, it implies that, on existing conditions, the mass of the people cannot afford to travel as often as they would do on more reasonable terms, or, in other words, on terms more suited to their means. The question is one mainly of third-class fares, for it is from this source that quite 90 per cent. of passenger receipts are derived at the present day. The second class must be regarded as a moribund institution, while the first class is on most lines unremunerative, and is maintained, in great measure, as a politic concession to a small but influential body of customers. The movement in the direction of one class is already well defined. Its complete success, coupled with low fares, on tramways, on omnibus routes, and lately on he Central London Railway, affords unmistakable igns of what we are coming to in the near future, in erving nine-tenths of the travelling public. Yet, in pite of these and other obvious indications of change, ur home railways still adhere stubbornly to the ' parliamentary" minimum fare of one penny per nile for all but cheap trips and "week end" exursions, and apparently disregard the broad hint vhich the profitable results of these deviations from he standard charge afford, viz., that by reducing the rdinary fare to, say, a halfpenny per mile, they would robably, if not certainly, get three persons to travel vhere they now get but one. They appear to conder the penny a mile as "bed-rock," and that any eparture from it is to be regarded more as a benevont concession, or hazardous, if not reckless, transction, than as sound and lucrative business. At the me that the "parliamentary" fare was established, ow more than fifty years ago, it was vehemently pposed, and mainly on the ground, then largely prealent, that the "cost of conveyance" was a fixed gure. It was not then seen, as it is now, that far om being fixed, the cost of moving passengers, or auling goods, varies up or down with the volume of affic dealt with. Every tyro in railway policy now nows as the alphabet of his business that if it costs, y, x to move 100 passengers, it does not cost $5x$ to ove 500. The penny a mile has long since been und to spell anything but ruin. No railway anager would for a moment think of increasing it. ut how many of them can see the mine of wealth hich lies waiting for those who will materially duce it?

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* A paper read by Horace Bell, M.Inst.C.E., at the International Engineering Congress, Glasgow, 1901.

The absence of systematic and detailed statistics for e railway in the United Kingdom in a large degree ccounts for the timidity, or we may call it nservatism, of their management. There are proably but few of our railway managers who are in position to unhesitatingly quote the prime cost moving a passenger or a ton of goods, as derived om the operations of any single year, or could do ore than guess at the cost of running expenses per ain mile; while the outlay per passenger-mile or per n-mile, which would include charges shown sepately for each department, would be to him no more an as a dream of perfection, or perhaps as a nightare of embarrassment. Yet, if we turn to the atistics annually offered for the American railways, , better still, for the Indian Railways, we find that r each system, under separate administration, there an invaluable review of its yearly operations, in ery detail, and for each department, and in a form clear as to render the results on any one line readily mparable with those of another. It is due in great easure to those statistics that the rates and taxes on dian Railways are probably the lowest in the world, d at the same time eminently profitable. Taking an instance the East Indian Railway, the figures r 1899 show that in this year the line carried a total $18\frac{1}{2}$ million passengers, of which 17 millions were the third or lowest class; that the average number of passengers in a train of all classes was 228; the average distance travelled was 61 miles; the cost of hauling one passenger one mile was one-eighteenth of a penny, and the fare charged one-fifth of a penny per mile, all debits included. Now, it may be readily allowed, in comparing the fixed charges (for operation only) and the running charges on this line, with those of some of our leading English lines, that the East Indian has some points in its favour; but these, after all, are as nothing in face of the fact that if the average income of the third-class passenger in England is taken, say, at £15 a month, that of the same class in India may be taken, and liberally, at no more than 15s.; that is to say, that in order to induce any passenger traffic at all, and one that was worth considering, the Indian railways have had to come down to rates which the English railway manager would have imagined impossible. They have found, however, that by moving very large numbers at very low fares the result is most profitable, and, in face of such figures as are given above, it is but reasonable to ask whether the penny a mile must be continued as the standard fare in the United Kingdom, *i.e.*, for ordinary journeys? The reply might be that the penny pays, and that any materially lower fare may not. Yet against this we have the fact that fares approximating to a halfpenny a mile, or indeed less, on the Central London, the District Railway, and the Glasgow Tramways, are, with large numbers, not only possible in a fiscal sense, but that, in the face of keen competition, it is the only way of getting the traffic. From such facts it seems fair to expect that if the halfpenny a mile was adopted generally on English railways, for all journeys, instead of the penny, that thousands, or rather millions, would largely increase the number of their railway journeys, and that, moreover, an entirely new stratum of travellers would be reached. It is further to be remembered that a development of passenger traffic is now well understood to bring with it a corresponding improvement in goods traffic.

It is not overlooked that the settlement of this question is no small matter, for it must be tested fairly, and on a sufficiently large scale, while the experiment may, or perhaps must, involve a considerable expenditure on additional rolling stock for at least main lines. The area on which the experiment would seem at first most likely to prove successful is on the railways serving the seaboard round London. There lies a field for the enterprising manager such as exists nowhere else in the world—a city of, let us say, five millions of sea loving people at one end and the sea at the other. Yet we find, at any rate for the third-class passenger, a poor and unpunctual service; a class of rolling stock which, until quite lately, was almost the worst in the country, and fares which, to the bulk of the people, make a visit to the seaside a rare luxury, while it should, and could, be the commonest holiday jaunt for the Londoner. With fares reduced to a halfpenny a mile, with a fast direct service, and with ordinarily decent carriages, thousands upon thousands of people who now perhaps go down to the sea once in the year, would come to regard such a trip with but little more hesitation than those who now fill the Pullman cars to Brighton and elsewhere. What can be more obviously prohibitive to the great lower and lower middle class than the present ordinary return third-class fares to Brighton (8s. 5d.), to Dover (12s. 11d.), to Margate (12s. 4d.), or Hastings (10s. 1d.), all at the inevitable penny a mile, and none of the places much more than 70 miles from London. At a halfpenny rate, and with an ample service of quick through trains, the present passenger traffic could probably be quadrupled, more especially if facilities for through booking were arranged with the District Railway; indeed, it is more than likely that it would pay to make entirely new direct lines, electric possibly, for no other purpose than to serve a through passenger traffic between London and the sea coast. But for the railways round London, at least, the halfpenny fares need not be confined to seaside traffic. It would effect a great development of suburban traffic, more especially on the shorter distances, and induce a far greater movement of the rural population to and from towns and villages from distances of 50 to 60 miles from the metropolis, a movement which is now inconsiderate, and which would well repay better attention on the part of railway men.

Conservatism appears to be the key-note of the policy of our railway companies. They seem to say:—"Our officials and our workpeople get their pay, the board gets its fees, and the shareholders their moderately good dividend. What more do you want?" The "more" that is wanted, is some attention to the claims of the British public, more regard for the interests of the shareholders, some attempt to shake off old-fashioned ideas, and to strike out in new directions. In any such attempts, they should recollect that every small advantage which the third-class passenger now has, as compared with his position fifty years ago, has been simply wrung from the companies against their vehement opposition, and yet not one of these would now think for a moment of returning to the old régime. The "parliamentary" train was discouraged by making it almost impossible for the third-class passenger to effect any long journey in daylight, even although he was expected to start at cock-crow, and was made to get out and wait at junctions; though even when his train arrived there might be no room for him. Conveniences of any kind, even for refreshment, were not even contemplated for this lowly type of traveller. Again, when the Midland Company, in 1872, boldly started to carry third-class passengers by all trains the other companies, especially the Great Western, lagged behind for a long while, and even to this day the South Eastern and Chatham companies run some trains either with first and second only, or with an extra charge for third-class. Again, the substitution of two classes for three, proposed or advocated by Mr. Gladstone so long ago as 1874, which has already been amply proved to be both politic and profitable, has not as yet been adopted generally, though it grows slowly. So it is with reduction of fares; the fare and a half, and the single fare, or, in other words, the halfpenny per mile, are already well to the front for trips and excursions, but for these only, though they show, without doubt, that full trains at these rates are distinctly remunerative. There are, in fact, but few lines on which the actual cost of carrying passengers in full trains can be more than half a farthing per head per mile, yet, though our railways have taught us to travel, they have not learnt their own lesson, which is to offer the necessary inducements to extend the habit. They go on with the same old "penny a mile," as if there was divine revelation in the figure, and as if our railway boards were not men of business but mere ornamental pluralists. In some cases, if not in many, the boards are held down by the inertia of their managers, as was notoriously the case on the Great Western, when in the able but very conservative hands of Grierson. His type is unfortunately still too common, and for the reason that by the time a man has worked up from the bottom of the ladder to the position of manager, he has too generally and not unnaturally lost his vigour and the spirit of enterprise. His policy is to let well alone. The better or the best may be left to others to try for. On the other hand, there are doubtless many younger men who, if given reasonable latitude of action, would soon show that the true policy of the administration of a railway is, as much as in any other industrial undertaking, to venture, to move forward, even if slowly, and to be content, not merely when they have met a demand forced on them, but when they have introduced facilities which will induce a further demand.

One acknowledged difficulty in carrying out a general and considerable reduction in third-class fares lies in the want of sufficient yard and platform accommodation at many of the older principal stations, and especially in London, if, as is almost certain, the halfpenny per mile fare led to trebling the number of travellers in the third class. At many of the smaller stations, as, for instance, on the Brighton and the South Eastern and Chatham lines, the same difficulty would be experienced, though this difficulty is after all almost entirely one of money, and is one that can be met gradually and tentatively as the demand develops. A similar but probably less immediate obstacle will be found in the need for a large increase in the rolling stock. But neither these nor other difficulties would stand in the way for long, when experiment had satisfactorily established that the reduction of fares would be profitable.

THE CANALIZATION OF AUSTRIA.

Austria has just adopted a measure for a system of canals that is of far reaching importance. This undertaking, it is expected, will do more than any thing yet accomplished to promote the commerce of the country, as it will not only bring the various provinces into closer touch, but will also afford the cheapest freight connections with Germany and Russia. The measure provides for (1) a canal from the Danube to the River Oder; (2) a canal from the Danube to the Moldau, near Budweis, in connection with the canalization of the Moldau from Budweis to Prague; (3) a canal from the Danube Oder Canal to the Upper Elbe, in addition to the canalization of the intervening Elbe bed as far as Melnik; (4) a canal from the Danube-Oder Canal to the Vistula, and to some navigable part of the Duiester. These navigable waterways, extending in length to over 1,000 miles, are, according to Consul-General Hurst, to be constructed by the State, with the co-operation of the provinces, districts, and towns, in particular the cities of Vienna and Prague, which are to furnish proportionate contributions. To guarantee the contributions, the Government is to commence negotiations with the interested provincial representatives, and with the municipalities of Vienna and Prague. It may be added that the contributions may be made either by single payment or by annual instalments, or through the construction of certain portions of the designed work—such as harbours, docks and streets leading to them—or through the session of land or relinquishment of other property rights, and of rights to the waterways to which those concerned might otherwise be entitled by existing laws. The work of construction must begin, at latest, some time during the year 1904. The necessary preliminary work must be so calculated that the whole system will be finished within twenty years. The cost of construction, in so far as this cost has not been already covered through the contributions of the various interested sections, is to be met by the issue of 4 per cent. (tax free) Government bonds, redeemable within ninety years. The Government is empowered to issue these bonds to an amount not to exceed £10,150,000 during the period of construction, from the year 1904 to the end of 1912, and the money thus raised shall be used only in building the designated waterways. In the expenses of construction after the year 1912, the necessary legislative measures will be taken later. The Government is authorised to determine finally the exact routes for the canals in question. Any deviation from the conditions of the programme already fixed by law, or for any extension beyond the limits of the prescribed plans, will require special legislative approval. All matters connected with the execution of the canal project are to fall within the jurisdiction of the Ministry of Commerce, which is entrusted with the carrying out of the work. The entire cost of construction is estimated at £30,430,000. The canals are designed to admit boats up to 600 tons burden. It will be seen from this scheme that the Austrian Government is making energetic efforts for the building up of her commerce. Although the topographical configuration will render the work of construction difficult, and the severe winters will close the canals for a considerable time each year, the system will be of incalculable benefit to the whole country, and will connect Austria more closely with her neighbours, Germany and Russia. Not only will the cost of freight from the German seaports be appreciably less, but many parts of the interior now practically inaccessible to trade can then be successfully developed. Coal lumber and other products, which in certain remote districts cannot be utilised on account of cost of transportation may then be brought into the market.

Correspondence.

IDENTIFICATION OF WOOD.

I was pleased to see Mr. J. S. Gamble's letter in your issue of Dec. 13th, and have very little to do, except to express my obligation to him for his additional information, and his corrections, which I freely accept.

The particular class of botanical publications to which my remarks referred, are such as occupy so much space in the Transactions of some of our scientific bodies, and of which the enumeration of the plants found during the *Challenger* expedition is a type. The many accomplished workers who have been connected with India have made the Indian Department of Forests the example of all the world.

I wish to say a word on behalf of Kew. I can readily endorse Mr. Gamble's testimony that the staff are most willing and anxious to help anyone who betrays the least interest in their work, but their difficulty is to find people who will undertake work that they cannot be expected to do. I have only to say that I have received no less than 24 cwt. of specimens from Kew during the last 12 months, to convince everyone that Sir William Thistelton Dyer is most anxious to make use of the material which is placed in his hands. What we want is a school of enthusiastic workers, who will deal with the economic material of the Kew Museum, in the same way as the systematic botanists do with the dried specimens of plants at the Kew Herbarium.

HERBERT STONE.

Little Hay-house,
Near Lichfield,
Dec. 14th, 1901.

The Society of Arts is under great obligation to Mr. Herbert Stone for his valuable paper on "The Identification of Wood." But why should he go out of his way to sneer at botanists [*i.e.* scientific botanists] "for omitting everything likely to be useful [*i.e.* to economic botanists, and especially lignologists], from their descriptions of plants:" And why should Sir Dietrich Brandis, a specialist of the most comprehensive understanding, and who must be so well aware of the signal services rendered by scientific botanists in India to Indian economic botany, why should he, above all men, emphasize the shallow sneer?

Although Mr. Herbert Stone's process of identification is a new departure in so far as he is systematically employing it for the identification of wood for economic purposes, it has always been followed in principle, with less perfect means of course, whenever necessary for the purposes of scientific botany. I was for three years class assistant to Professor John Hutton Balfour, and prepared the demonstrations for the class-room, and whenever necessary timbers of various trees, both in blocks and in microscopic sections, were exhibited to the students, not, indeed, expressly to distinguish one wood from another for economic purposes, but rather to illustrate either the physiology of plant life, or the differences in the general appearance of the woods produced in the different so-called "Natural Orders" of systematic botanists. And after all, Mr. Herbert Stone's process is but the completest and best so far devised for the *universal* identification of woods. If you are only dealing with a few "musters," there are other processes just as effective. I was at one time devoted to wood-turning—and I may say rather deft at it—and after two or three years practice I was able to identify the wood I was using blindfold, by its specific weight, its feeling in the hands, its smell, its taste, and its spinning hiss against the edge of the chisel held to the lathe. Again, it could be identified by the falling curve of the chips it threw off from the lathe, and by the curl of its shavings; and again, when burnt, by the "volumes" of its smoke, and the varied forms these took when deposited on a sheet of white cardboard held above the fume. All these are means for the practical identification of woods for multifarious economic purposes,—with which, however, scientific botanists have no responsible concern whatever, albeit they habitually do interest themselves in the uses of the plants they describe.

Sir Dietrich Brandis very properly commended Mr. Herbert Stone for speaking in plain terms, and not in technical ones,—even as these botanists of his momentarily monocular [Cyclopic] vision. He says:—"For example, he (Mr. Herbert Stone) did not speak of medullary rays, but only of rays." The example is a bad one, as the botanical phrase, "medullary rays," not only describes, but in some measure explains the "plates" connecting the pith with the bark of trees. And why not say "medullary rays," just as well as "annual rings," a phrase which Mr. Herbert Stone actually uses; as he also does the technical term "parenchyma," a word of ambiguous etymology, and therefore somewhat arbitrary meaning, which is "interposed tissue" rather than "soft tissue."

In a word, this sort of girding at botanists by "lignologists" seems to me childish. It is mere kicking against the pricks, and all in vain; for while the botanist can do without the expert "lignologist," the latter cannot do without the botanist; botany, if it is to be kept "up to date," being a sedulously laborious, and all absorbing science, which few experts in any department of vegetable economics can effectually pursue along with their own specialised work.

But this has ever been the way with good "lignologists," as the "foresters" of my youth now prefer to call themselves. Dr. Alexander Gibson—"Daddy Gibson"—once questioned me on the identification of two very similar logs of wood, both of which he had himself hewn from two different unspecified trees. I very humbly asked if he had kept any flowers of the trees, or taken any drawings of their flowers, showing, particularly, the relative position of the stamens and the pistils. "Stamen and pistils!" he roared at me, like another Polyphemus,—"They have no more to do with the question than the confounded distinctions of the Athanasian Creed!"

GEORGE BIRDWOOD.

December 7, 1901.

P.S. (December 14).—I gladly postponed the publication of the above protest when I found that Dr. Gamble had sent in the note published in today's issue of the *Journal*; and not only because of the historical importance of his bibliographical statements, but on account of his authoritative defence of Kew against the heedless and unintelligent criticisms to which it was subjected by some of those who spoke in the discussion on Mr. Herbert Stone's most interesting paper. But, for my own part, it was not these criticisms which surprised and amazed me, but the fact of their having been in any way endorsed by Sir Dietrich Brandis. That fell on me like "a bolt out of the blue,"—the bright abiding place of Pallas Athene.—GEO. B.

MEETINGS OF THE SOCIETY.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

LECTURE I. — Photographic Optics — Pinhole Photography—The Lens: its Defects and their Correction—Instantaneous Photography—Movements of Animals, &c.—Photography by the Electric Spark—Flying Projectiles—Falling Drops—Sound Waves—Stellar Photography—Photography and the Spectroscope—Photography of the Unseen — Photography the Hand-maid of Science.

LECTURE II. — Photographic Chemistry — The Sensitive Surface—The Negative and its Development—Photographic Printing—Photography and the Printing Press—Reproduction of Colour by Photography — Photography in Colours — Miscellaneous Applications.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Wednesday Afternoon, January 1, 1902, 5 p.m. (Juvenile Lecture).—Sir Henry Trueman Wood, M.A., Secretary of the Society, "Photography and its Applications."

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday afternoons, January 1 and 8, 1902, at 5 o'clock, by Sir Henry Trueman Wood, M.A., Secretary of the Society, on "Photography and its Applications."

In addition to a large number of photographs and lantern slides, the lectures will be fully illustrated by experiments, amongst which it is hoped to include an exhibition of the "Animatograph" and the taking of a flash-light picture of the audience.

As a sufficient number of tickets to fill the room have now been given out, it will not be possible to issue any further tickets.

If any member is unable to use a ticket which has been sent to him, its return will enable some other member to be accommodated.

Members are reminded that special tickets are required for these lectures, and that admission cannot be obtained without a ticket.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CONFECTIONERS' MATERIALS AND PROCESSES.

By William Jago, F.C.S., F.I.C.

Lecture I.—Delivered November 25th, 1901.

Introduction.

Curiously enough, the word "confectionery" is used with somewhat different meanings on opposite sides of the Atlantic. Our American cousins apply the term to those delicacies which they also call "candies," while we use it in a much wider sense. If confectionery be the art of making "confections," it becomes necessary to inquire as to what a confection really is. The dictionary does not greatly help us, as there it is defined as a "sweetmeat." Going a little further, one looks upon a confection as a dainty manufactured article, appealing to the eye because of its appearance, and to the palate because of its exquisite taste. If these conditions be fulfilled, we grant a title to goods of a widely diversified nature to be included in confectionery, and in fact, so wide is the range, that a subdivision becomes necessary at the very outset of the study of our subject. Among articles sold by the confectioner are many which partake of the nature of cakes, and while these are certainly confections, they belong to a different category from sweetmeats, or, conventionally, "sweets" proper. It is a convenient classification to include in one group those goods of which the cake may be taken as a type, and into which flour enters as an essential constituent, and call them flour confections. The second group may then include those goods of which sugar is the basis, and which may be viewed as sugar confections. Not only is this a natural, but it is also a very real division, since the manufacture of flour confectionery and of sugar confectionery respectively are two separate trades carried on by distinct and different workmen.

Before entering further on the subject-matter of the lectures as described by their title, it may be well to emphasise the fact that they deal with the *chemistry* of the subject. The appearance of things is governed by the colour of the glasses through which they are viewed; and so with this subject—we are looking at it through the chemist's spectacles. There are many topics on which the expert manufacturing confectioner could speak to you with far greater authority than your present lecturer; and, although I may ask you to follow me into more or less detail of manufacturing processes, I will also ask you to remember that after all, it is the *chemist* who is attempting to be your guide, and not the manufacturer himself. To the chemist, the problem of the bearing of analysis on the purity and commercial valuation of materials is an ever present one, and a special effort will be made in these lectures to deal with the chemical valuation of substances passed under review.

Flour Confectionery.

(Basis—Varieties of Flour.)

Taking this division of our subject first; as already indicated, flour is the basis of these goods, and hence is the first material of the flour confectioner.

Flour.—Flour is well known to you all as a fine creamy white powder, consisting of the ground endosperm of the grain of wheat, separated from the germ and the branny envelope. Flour, because of its vital importance in bread-making, has been exhaustively discussed on this platform by an illustrious predecessor of mine, Dr. Graham, and it is therefore scarcely necessary to describe its properties in detail. It is now practically common knowledge that flour mostly consists of carbohydrates, of which starch is the most important, and a peculiar proteid substance known as gluten, which in its wet condition forms a mass resembling india-rubber in its consistency. It is this gluten which enables wheaten flour to make a tenacious dough material as distinct from the non-coherent powdery mass that would result from moistening rice-flour for example. Flours containing a high proportion of gluten, are termed strong flours, and are characterised by absorbing a large proportion of water, making a very stiff and elastic dough, and yielding a highly nourishing loaf. Flour with a low proportion of gluten are weak flours, with comparatively little absorbing power, and correspondingly low nutritive value. Flours of the former type are largely obtained from the wheat fields of Canada and the adjoining United States, while our English wheats belong to the weaker variety. The bread-maker will naturally prefer a flour with a high absorbing power, since all else being equal, the cost of making dough with a larger percentage of water is obviously less. But with the confectioner, the moistening ingredients are in most cases more expensive than his flour, and consequently it is to his interest to use a flour which shall obtain its desired degree of moistness with the minimum of these more expensive materials. Further, the weaker and softer flours lend themselves more readily to the manipulation and working necessary, than do those of stronger nature. It should also be noted that in bread-making, the flour during the operation of fermentation undergoes considerable softening, while no similar changes occur in the manufacture of confectionery. For these various reasons, therefore, the confectioner usually selects a weak and somewhat soft flour containing much starch and comparatively little gluten. For the sake of the colour of the cakes or other manufactured goods, a flour of a white or delicate creamy tint is preferred. Among flours used by the confectioner, and answering more or less to this description, are finest flours from English wheats, Hungarian flours, and those from the softer white wheats of North America.

To a limited extent in the manufacture of biscuits a finely ground whole meal is employed. A new departure in this direction is that of taking the separated bran and germ of such meal and subjecting them to the diastasic action of the extract of malt. This materially softens the bran, and liberates the nourishing matter contained within its cells. The bran and malt extract are then carefully dried down together, finely ground, and returned to the remainder of the meal. The malto-meal thus manufactured contains in an easily assimilable form the nutritive matter of the whole wheat, without any of its irritating properties, combined with the flavour and aroma of fresh malt. Samples of such meal are before you, and also biscuits made from same, to which Messrs. Peek, Frean, and Co. have given the name of "Argus."

Moistened with Milk and Eggs.

While the bread baker is content with water to moisten his flour for bread, the cake maker selects some richer material. Among these, milk holds a very prominent place, and requires a somewhat extended reference. There is probably no substance of which so many analyses have been made, as milk, and consequently, its composition and variations of composition, are well-known. Milk is used by the confectioner in at least three distinct forms —new milk, skim or separated milk, and sour separated milk. This latter is at times supplied mixed with butter-milk, and has special uses, to which reference will again be made. The following Table, based on the authority of Vieth and Richmond, gives the average composition of pure new milk:—

Fat		4·0
Proteids	3·6	
Sugar	4·5	
Ash	0·7	
Total non-fatty solids		8·8
Water		87·2
		100·0

By the removal of fat the percentage of other solid bodies in milk is slightly increased, and separated milk has about the following average composition:—

Fats		0·3
Proteids	3·7	
Sugar	4·6	
Ash	0·7	
Total non-fatty solids		9·0
Water		90·7
		100·0

The fat of milk, like that of other fats, confers richness on cakes, and will be dealt with in detail in the second lecture of this series. The sugar present in milk is a special variety, to which the name of lactose has been given; it differs from cane sugar in that it is far less sweet, and hence is not such a powerful flavouring agent as sugar of the latter description. The remaining constituent of milk of importance to the confectioner is the proteid matter. This last has, like the white of egg, no very pronounced taste, but yet its presence confers on milk a fullness and roundness of flavour (if phraseology may be borrowed from other tasters' vocabularies) which a simple solution of lactose in water would not possess. In the baked goods, the proteid of milk produces a moistness and mellowness of character, which decidedly differs from that caused by water only. Summing up, new milk gives richness through its fat, sweetness through its sugar, and what for lack of a better term, I will call "mellowness" through its proteids. Separated milk is practically new milk less its fat.

The composition of milk has been indicated in the analyses already quoted, but these figures must not be viewed as by any means the lowest obtainable from undoubtedly pure samples of milk. For purposes of the Food and Drugs Adulteration Act, the limits have been recently adopted of 3 per cent. of fat, and 8·5 per cent. of non-fatty solids. In the case of a milk falling below these limits, the onus of proof of its purity lies with the vendor. But for confectioners' purposes, a direct estimate of value is of more importance than knowing whether or not a particular sample of milk passes the limits of the public analyst. Thus milks containing respectively 3 and 4 per cent. of fat, would, so far as the fat is concerned, be passed as free from adulteration; but evidently the former sample has only three-fourths the value of the latter. For some years this subject of the valuation of milks has engaged the attention of the lecturer, who suggests, and has for some considerable time employed a standard of valuation worked out on the following lines:—From an examination of a large number of commercial mills an average conventional standard of quality was first determined, the aim being not to go so low as the Government limit for adulteration, but to take figures which a buyer might reasonably demand to be reached in milks supplied to him. These were ultimately taken as being for

	New Milk.	Separated Milk.
Total solids	12·5	9·3
Fat	3·5	0·3
Non-fatty solids	9·0	9·0

At the time when these figures were adopted, the approximate wholesale prices of milk were, new, 10d. per gallon; separated, 2½d. per gallon. New milk differs essentially from separated in that it contains an excess of 3·2 per cent. of fat. According to the wholesale prices this excess of fat has a market value of 7½d., and in the same proportion 3·5 per cent. of fat is worth 8·2d. From this the value of our conventional standard samples can be expressed in terms of their constituents:—

	New milk.	Separated milk.
Fat	3·5 = 8·2d.	0·3 = 0·7d.
Non-fats	9·0 = 1·8d.	9·0 = 1·8d.
per gallon	10·0d.	2·5d.

If the value of standard new milk be called 100, then the value of any other sample can from the analysis be expressed in terms of percentages of the standard from the following Table:—

VALUATION OF MILKS.

Fat in Terms of Standard.

Fat per cent.		Standard per cent.		Fat per cent.		Standard per cent.
0·1	=	2·34	....	2·5	=	58·57
0·2	,,	4·69	....	2·6	,,	60·92
0·3	,,	7·03	....	2·7	,,	63·26
0·4	,,	9·37	....	2·8	,,	65·62
0·5	,,	11·71	....	2·9	,,	67·95
0·6	,,	14·06	....	3·0	,,	70·29
0·7	,,	16·40	....	3·1	,,	72·63
0·8	,,	18·74	....	3·2	,,	74·98
0·9	,,	21·09	....	3·3	,,	77·32
1·0	,,	23·43	....	3·4	,,	79·66
1·1	,,	25·77	....	3·5	,,	82·00
1·2	,,	28·12	....	3·6	,,	84·34
1·3	,,	30·46	....	3·7	,,	86·68
1·4	,,	32·80	....	3·8	,,	89·02
1·5	,,	35·14	....	3·9	,,	91·36
1·6	,,	37·49	....	4·0	,,	93·70
1·7	,,	39·83	....	4·1	,,	96·04
1·8	,,	42·17	....	4·2	,,	98·38
1·9	,,	44·52	....	4·3	,,	100·72
2·0	,,	46·86	....	4·4	,,	103·06
2·1	,,	49·20	....	4·5	,,	105·40
2·2	,,	51·55	....	4·6	,,	107·74
2·3	,,	53·89	....	4·7	,,	110·08
2·4	,,	56·23	....	4·8	,,	112·42

Non Fatty Solids in Terms of Standard.

Non-Fatty Solids per cent.		Standard per cent.		Non-Fatty Solids per cent.		Standard per cent.
4·8	=	9·6	....	7·2	=	14·4
4·9	,,	9·8	....	7·3	,,	14·6
5·0	,,	10·0	....	7·4	,,	14·8
5·1	,,	10·2	....	7·5	,,	15·0
5·2	,,	10·4	....	7·6	,,	15·2
5·3	,,	10·6	....	7·7	,,	15·4
5·4	,,	10·8	....	7·8	,,	15·6
5·5	,,	11·0	....	7·9	,,	15·8
5·6	,,	11·2	....	8·0	,,	16·0
5·7	,,	11·4	....	8·1	,,	16·2
5·8	,,	11·6	....	8·2	,,	16·4
5·9	,,	11·8	....	8·3	,,	16·6
6·0	,,	12·0	....	8·4	,,	16·8
6·1	,,	12·2	....	8·5	,,	17·0
6·2	,,	12·4	....	8·6	,,	17·2
6·3	,,	12·6	....	8·7	,,	17·4
6·4	,,	12·8	....	8·8	,,	17·6
6·5	,,	13·0	....	8·9	,,	17·8
6·6	,,	13·2	....	9·0	,,	18·0
6·7	,,	13·4	....	9·1	,,	18·2
6·8	,,	13·6	....	9·2	,,	18·4
6·9	,,	13·8	....	9·3	,,	18·6
7·0	,,	14·0	....	9·4	,,	18·8
7·1	,,	14·2	....	9·5	,,	19·0

In the following Table (p. 97) are given the results of analysis of some typical examples of milk, their value in terms of standard and per gallon, assuming standard milk to be worth 10d. per gallon.

Attention is drawn to the fact that milk No. 7, although of highest value in terms of standard, shows, nevertheless, evidence of having been watered, and would probably be made the subject of a prosecution if analysed for the purposes of the Foods and Drugs Act. The public analyst is concerned simply with adulteration, while the commercial user is more vitally interested in the question of actual value.

A gallon of milk weighs approximately about 10·3 lbs. or 10 lbs. 5 ozs., and if this be bought at 10d., the purchaser gets, if the milk is of standard value, 0·36 lbs. = 5·76 ozs. of butter fat, for which he pays 8·2d., or at the rate of 22·7d. per lb.; and 0·93 lbs. = 14·88 ozs. of mixed proteid, milk-sugar, and ash; for which he pays 1·8d., or at the rate of 1·9d. per lb.

A gallon of separated milk of standard value weighs about 10·5 lbs. or 10 lbs. 8 ozs., and if this be bought at 2½d., the purchaser gets 0·03 lbs. = 0·48 ozs. of butter fat, and 0·945 lbs. = 15·1 ozs. of mixed proteid, milk-sugar, and ash, making 0·975 lbs. of total solids, which he buys at the rate of 2·56d. per lb.

Taking butter, containing 87 per cent. of butter fat, at 1s. per lb., then —

One gallon of separated milk, costing		2½d.
And 0·33 lbs. of butter, costing	..	4½d.
Together costing		7d.

will yield the equivalent in quantity of the total non-fatty solids, and butter-fat of one gallon of new milk costing 10d. Condensed milks of the unsweetened variety, are at times employed instead of new or separated milks. In ascertaining the value of these, it is well to dilute them to three times their original volume. Then such a milk as No. 9 is, as nearly as possible, of the same degree of concentration as our standard milk. One gallon of such milk, in the concentrated form, is worth, as against standard milk,

$$9{\cdot}8 \times 3 = 28{\cdot}4\text{d. per gallon.}$$

No. 10 has been deprived, before condensing, of nearly half its fat, and consequently is only worth

$$6{\cdot}4 \times 3 = 19{\cdot}0\text{d. per gallon.}$$

Such condensed milks may not only be diluted and used as moistening agents, but also at times are employed in their concentrated state, as a more or less complete substitute for butter. These condensed milks have, or should have, an approximate density of 1·1, and therefore, a gallon of No. 9 will weigh about 11lbs., and is worth, on the milk standard, 28·4d. or 2·58d. per lb. A gallon of the milk will contain, roughly, 2·70 lbs. of non-fatty solids, and 1·15 lbs. of butter fat. This is the equivalent in quantity of 2·85 gallons of separated milk, at a cost of 7·1d. and 1·32 lbs. of butter which, at 1s. per lb. costs 15·8d., or a total of 22·9d. Unless, therefore, such full value milk as No. 9 is bought at 2·08d. per lb., its proteids, milk-sugar and fat, can be more cheaply supplied from separated milk and butter.

No.	Description of Milk.		Composition.	Value in terms of standard.	Value per gallon.
1.	Milk with 26 per cent. of added water....	Fat	3·2	74·98	
		Solids not fat....	6·6	13·20	
			9·8	88·18	8·8d.
2.	Milk deprived of 40 per cent. of its cream ..	Fat	1·8	42·17	
		Solids not fat....	9·1	18·20	
			10·9	60·37	6·0d.
3.	Old Somerset House limit, below which milks were considered adulterated	Fat	2·5	58·57	
		Solids not fat....	8 5	17·00	
			11·0	75·57	7·5d.
4.	Present Government limit	Fat	3·0	70·29	
		Solids not fat....	8·5	17·00	
			11·5	87·29	8·7d.
5.	Lecturer's conventional standard	Fat	3·5	82·00	
		Solids not fat....	9·0	18·00	
			12·5	100·00	10·0d.
6.	Average composition of pure new milk	Fat	4·0	93·70	
		Solids not fat....	8·8	17·60	
			12 8	111·30	11·1d.
7.	Very rich milk slightly watered............	Fat	4·3	100·72	
		Solids not fat....	8·1	16·20	
			12·4	116·92	11·7d.
8.	High quality sample of skimmed milk	Fat	0·4	9·37	
		Solids not fat....	9·1	18·20	
			9 5	27·57	2·76d.
9.	Unsweetened condensed milk diluted to three times its volume	Fat	3·5	82·00	
		Solids not fat....	8·2	16·40	
			11·7	98·40	9·8d.
10.	Unsweetened condensed milk diluted to three times its volume	Fat	2·0	46·86	
		Solids not fat....	8·6	17·20	
			10·6	64·06	6·4d.

Eggs.—Next to milk, eggs are one of the most important moistening agents to the confectioner. The contents of the egg, both yolk and white, are so well-known to every one, that any description of their appearance is unnecessary. It may be well to remind you, however, that the raw white of egg is a viscous glairy liquid, the yolk being somewhat more liquid in character. In composition, the white of egg consists of proteid matter dissolved in water, while the yolk contains in addition to proteid, fat and colouring matter. The following Table gives respectively the results of analysis of the white, yolk, and whole interior of the egg:—

	White.	Yolk.	White and yolk together.
Water	85·7	50·9	73·7
Proteid	12·6	16·2	14·8
Fat	0·25	31·75	10·5
Ash	0·59	1·09	1·0

The white of egg may be viewed as a solution of one part of albumin in seven parts of water, while in the whole egg about two-fifths of the solids consist of fat, and three-fifths of proteid matter. The water of the whole egg amounts roughly to three-quarters of its weight. Or putting it another way, 1 lb. of whole eggs contain about 4 oz. of solids, and 1 lb. of white of egg just half that quantity or 2 oz. When either of these are used in making a dough with flour, the water part of the egg does the moistening, and acts in the same way on the constituents of flour as water alone would do. The white, if used alone, is so nearly tasteless that it cannot be said to confer any very decided flavour; but, as was remarked with regard to the proteid matter of milk, it imparts the property described as that of mellowness to goods in whose manufacture it is used. The yolk, on the other hand, is very marked in flavour, and just as eggs themselves are in consequence most pleasant eating, so cakes have a remarkable richness of flavour caused by the yolks of eggs used in their manufacture.

The yellow of the yolk confers its distinctive colour on the cakes and other goods in which it is employed; as a consequence the full yellow of a cake has become associated with the idea of its richness. With cakes made at very low prices, the use of eggs in full proportion becomes an economic impossibility, and therefore, in the cheaper cakes, an effort is made to please the eye by adding artificial colouring matter. For this purpose vegetable yellows may be employed; and in fact, in the West of England, the saffron bun is a well-known and popular institution. Not only is saffron here used as a colouring matter, but also as a flavouring agent, for such saffron buns have a distinct taste of their own, which is entirely lost if the saffron be omitted. Other vegetable colours are also used; but the greater number of egg yellows and egg colourings offered to the confectioner, belong to the group known popularly as aniline colours. Some time ago, I examined a large number of so-called egg-yellow colourings, including practically every make of importance on the market; and among other things investigated their tinctorial power weight for weight, and price for price. In tinctorial power, as against unit weight, the most intense colour was about 180 times as strong as the weakest. In the matter of cost for the same amount of colour, some samples were just 30 times as expensive as others. On being tested for arsenic, the great majority of these colours were absolutely pure; some one or two, however, gave a sufficient arsenic reaction to make their use inadvisable. When it is remembered that these colours are offered at prices of from 1s. to 10s. 6d. per lb., it will be seen that accurate scientific valuation becomes a matter of importance. Samples are here shown you of such various colours dissolved in water in the proportion of 1 part per 1,000; the differences in depth of tint are very obvious. This last tube contains a specimen of colouring which has been the subject of adverse comments by experienced confectioners, who have condemned it as being a very bad imitation of the effect produced by eggs. I may say that it consists of an ethereal solution of colour obtained by direct extraction of the yolks of eggs themselves.

For certain purposes, in place of the white of eggs, the confectioner has offered to him such whites as desiccated albumin. This preparation should consist of the pure fresh white of egg evaporated down to dryness at a temperature well below that of the coagulation or setting of albumin. Such dried albumin should soften on the addition of water and form a solution possessing the same properties as fresh white of egg. The solution should be free from any unpleasant taste or odour of decomposition. As white of egg contains one-eighth its weight of white albumin, it follows that dried egg-albumin should, everything else being equal, be worth weight for weight eight times as much as fresh white of egg. In other words, pure egg-albumin at anything below eight times the cost of white of egg is economically to be preferred to such fresh whites. The objections to such commercial albumin are first, that it may be partly coagulated, and second, that it may be unpleasant in odour or taste either as the result of preparation from unsound eggs, or incipient putrefaction during its manufacture.

Among adulterants likely to be found present are dextrin, sugar, and gelatin. Serum- or blood-albumin, is less expensive than egg-albumin, and so may possibly be substituted for it without declaration to the purchaser. It follows that confectioners using egg-albumin should, from time to time, make a point of having its purity carefully checked by analysis.

Before altogether passing on from moistening action, a word may be appropriately said here on the moistening effect of melted fat, as butter or lard. Such moistening is quite different in character from that of substances whose essential moistening constituent is water. The latter all affect the gluten of flour, and produce a dough such as is used in making bread; the former makes a moist mass, devoid altogether of any tenacity, but, instead of that, distinctly "short." You have an example of the use of butter fat as a moistening agent in the deservedly popular Scotch confection, shortbread.

In another sense of the word "moistening," glycerin must be mentioned as one of the confectioners' moistening agents. Glycerin is well known as a colourless, odourless, and viscous liquid, of a very sweet taste. If exposed to the air, glycerin increases in volume through absorption of moisture. Chemically speaking, glycerin is a compound of carbon, hydrogen, and oxygen, belonging to the alcohol type. When used in small quantities in cakes, the result is that drying is much retarded, and the cake remains moist and fresh for a considerable time longer than would otherwise be the case. As glycerin is without injurious effect on the human economy, its use in this direction may be regarded as perfectly harmless.

MADE LIGHT BY AËRATING AGENTS.

If you take a lump of dough made from plain flour and water, and put it in the oven, the result is a heavy and the reverse of appetising mass. The skill of the baker is directed to producing a loaf which is light and porous, and whch, if cut, is seen to be full of little vesicles. The confectioner is animated by the same motives, and secures lightness in many of his wares in precisely the same manner. Thus, practically the whole group of buns are fermented just as bread by the addition of yeast. The sugar present in such bun-dough is changed by fermentation into alcohol and carbon-dioxide gas, and this latter distends and lightens the dough. Although the confectioner acquires lightness for his doughs by a diversified number of methods, yet in almost all of them it is on the production of carbon dioxide that he relies.

Let us take a few examples of such aërating agents; and, among them, one of the first is the solid commercial ammonium-carbonate, called by the confectioner, "ammonia" or "volatile." This salt may be represented by the formula $2(NH_4)\ 2CO_3.CO_2$ and is a mixture of the carbonate and *carbamate* of ammonium. The compound has an ammoniacal smell and an acrid burning taste. On the application of heat, "volatile" is decomposed into gaseous ammonia, water, and carbon-dioxide gas. The commercial salt should be almost free from non-volatile bodies, and good specimens will leave only a trace of fixed foreign matter after being subjected to a temperature of 100° C., the actual quantity being from 0·04 to 0·4 per cent. As the composition of the salt varies, its strength may be determined by an estimation of the alkalinity, titrating with sulphuric acid, and using methyl orange as an indicator. The salt is continuously losing ammonia, and so becomes weaker. Commercial samples vary in strength from an alkalinity equivalent to about 80, to one of about 93 per cent. of the pure salt. If ammonium carbonate be mixed with the other constituents of a dough, there is very little change until the goods are placed in the oven. With a rising temperature, the liberated carbon dioxide and ammonia gases distend the mass, and so produce the desired lightness. When withdrawn from the oven, such goods may smell and taste most strongly of the ammonia. With small articles of a porous texture, this smell soon completely passes off, but with larger ones this does not occur at all so readily, and for this reason "volatile" has to be used sparingly and cautiously by the confectioner.

Sodium bicarbonate is another salt capable of giving off gas, under the action of heat alone. This compound, $NaHCO_3$, then becomes the normal carbonate, Na_2CO_3, with the evolution of steam and carbon dioxide. A temperature of 38° C. (100° F.) is sufficient to complete this change. Sodium bicarbonate has only a slight brackish flavour, but the normal carbonate has a strong alkaline taste. For this reason, and because only half its gas is evolved by heat, the bicarbonate is but seldom used alone. The objectionable flavour is, however, the much more pressing reason of the two, because a double quantity of the carbonate would cost much less than the amount of acid necessary to act on the one portion of carbonate only. Commercial bicarbonate of soda is obtained of a high degree of purity, and usually gives an alkalinity very nearly equivalent to 100 per cent. of the pure salt. At times figures are obtained which even go beyond this, and one is confronted with, perhaps, apparently 103 per cent. In such cases the explanation lies in the fact that the salt contains more or less normal sodium carbonate as impurity. In the analysis of the bicarbonate it is always well to search for, and estimate approximately if necessary, the quantity of normal carbonate present. In using bicarbonate great care must be taken that the salt is finely ground and intimately mixed with the flour and other constituents of the dough. Neglect of such precautions leads to the formation of small masses of the normal carbonate during baking, and these in turn act on the proteid constituents of flour with the production of a yellow stain or spot. Further, flour thus acted on by normal carbonate evolves an unpleasant soapy odour. Like ammonium carbonate, the bicarbonate of soda only commences to evolve gas when subjected to the heat of the oven.

When sodium bicarbonate is treated with an acid, the whole of the carbon dioxide gas is evolved, and the corresponding salt formed. Of all acids, that found most convenient by the confectioner is tartaric acid, either in the free state or as its acid potassium salt. Tartaric acid is widely distributed in nature, and is manufactured from some of its compounds occurring in grape juice. The acid occurs in commerce as a fine white powder, having a clean acid flavour, and is very soluble in water. When tartaric acid and sodium bicarbonate are mixed in with flour in equivalent quantities, the result, by moistening with water, is, that the acid attacks the carbonate, liberating all its carbon dioxide, and forming normal sodium tartrate. This latter salt is comparatively tasteless, and the presence of the quantity produced as a residue from the amount of acid and soda necessary for the aëration of an average dough is not sufficient to injuriously affect the flavour of the resultant goods. The action of tartaric acid and the bicarbonate, or more shortly "soda," commences immediately on the addition of water, and, for that reason, it is well to get the dough into the oven as speedily as possible. Then, with the greater heat, solution of the two re-agents, and their consequent mutual action, go on with augmented speed. Tartaric acid being somewhat expensive, it is important that no waste of it should occur, and as all, mixed in a dough, that is in excess of the equivalent of the soda is lost, it is well to remember that 15 parts by weight of tartaric acid equal 17 parts of soda. Tartaric acid should on analysis show an acidity equal to 99 (or upwards) per cent. of pure acid, and the ash should not exceed 0·25 per cent. Tartaric acid is said to have been adulterated with alum and acid potassium sulphate; but both these would be detected by an abnormally large percentage of ash, and also by the presence of sulphates.

Not only is tartaric acid itself employed, but so also is its acid potassium salt, cream of tartar. Tartaric acid being a dibasic salt, the cream of tartar consists simply of that acid, with one of its atoms of "acid" hydrogen replaced by potassium. Cream of tartar exists in the crust or tartar deposited by wines on keeping, and is obtained by a process of solution, purification, and re-crystallisation. The salt occurs commercially as a white powder, and differs from tartaric acid in that it is only very slightly soluble in cold water, one part of the salt dissolving in about 250 of water at 50° F., whereas boiling water dissolves it in the proportion of one part of "cream" in 15 parts of water. To the confectioner, this is a most important property, because as a result, a mixture of cream of tartar and bicarbonate of soda, as an aërating agent, is almost inactive in the cold. Doughs made with this mixture, undergo little or no aërating change until placed in the oven. Then the rise in temperature results in solution of the cream, and its consequent action on the bicarbonate. This salt therefore becomes active just at the time when such activity is most effective. The salt resulting from the action of these two reagents on each other, is well known under the name of "Rochelle Salt." It possesses only a bland saline taste, and hence, does not sensibly effect the flavour of goods in the manufacture of which "soda and cream" are employed.

Most samples of cream of tartar contain calcium tartrate as an impurity, the amount varying from 2 to 9 per cent.; when the proportion is in excess of this, it should be regarded as an adulterant. Good samples of cream of tartar should show an activity equal to from 96 to 98 per cent. of pure acid potassium tartrate. Among other adulterants found in this substance, are the acid sulphate of potassium, alum, plaster of Paris, and starch.

In mentioning milk at an earlier stage of this lecture, reference was made to sour milk, and special uses made of it by the confectioner. In conjunction with bicarbonate of soda, sour milk forms a useful aërating agent, and in consequence is employed in the manufacturing of scones and similar goods. The lactic acid of the milk reacts on the soda, forming sodium lactate, and evolving carbon dioxide gas.

Tartaric acid has been mentioned as the one of most importance to the confectioner. Among more or less successful substitutes are acid potassium sulphate, acid calcium and potassium phosphates, and phosphoric acid. The three former are obtainable as white powders, and mixed with starch in various proportions are used as substitutes for tartaric acid and cream of tartar respectively. In older confectioners' récipes alum is sometimes included as an ingredient; this body has a powerful acid reaction, and with soda can be used as an aërating agent. In view of the injurious nature of alum, its employment need only be mentioned in order to condemn it, and to point out that some non-injurious form of acid should be used in its stead.

In our syllabus, reference has been made to the lightening action of eggs. It is well-known that, under certain circumstances, eggs are valuable lightening agents, yet they do not give off any gas whatever, within the range of temperature employed by the confectioner, neither do they cause evolution by gas, from any other ingredients he is in the habit of using. In these particulars they differ markedly from the aërating agents we have just passed in review, and their action must consequently be looked for in some other direction. First of all, eggs, and especially their whites, have a peculiar glairy consistency. In virtue of this, if eggs be present in a mixture, any air incorporated with it prior to baking, is retained much more tenaciously. Consequently, when the goods are placed in the oven, such air expanding with increase of temperature, increases the volume of the articles by its more perfect retention, as a result of the peculiar viscous and binding nature of the egg-albumin. Another valuable property of eggs, so far as this effect is concerned, is that of setting or coagulation. Just as in being boiled, the egg matters become solid during the act of baking: as the temperature of coagulation is reached they begin to set, and so fix the dough, so to speak, in its expanded state. The lightening function of eggs is therefore summed up in the statement that they do not of themselves evolve or cause the evolution of gas, but assist in its retention when developed by the expansion of air, or obtained from any other gaseous source.

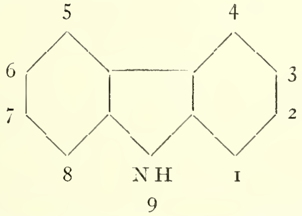
[The lecture was followed by a demonstration of biscuit-making processes by means of a large working model. Samples of biscuits in their various stages of manufacture were also exhibited. The specimens of confectionery, &c., used in illustration of the lecture, and also the succeeding demonstration, were kindly provided by Messrs. Peek, Frean, and Co.]

Miscellaneous.

NEW OR MODIFIED PHOTOGRAPHIC PROCESSES, BASED ON THE SENSITIVENESS OF AZO-DERIVATIVES.

Otto Ruff and Victor Stein have, by some recent researches, given a new interest to the Primuline method of photographic printing; a method very fully detailed by the inventors, Messrs. Green, Cross, and Bevan, in a paper communicated to the Society of Arts in the year 1891 (*Journal of the Society of Arts*, January 23, 1891, vol. 39, p. 150).

The researches of Messrs. Ruff and Stein are described in a communication read before the German Chemical Society in May, 1901, and the full text is to be found in the Journal of the Society in question (*Berichte der Deutschen Chemischen Gesellschaft*, xxxiv., p. 1668). It will be remembered that Messrs. Green, Cross, and Bevan, in their communication to the Society of Arts, called prominent attention to the fact that the aromatic diazo compounds are, as a class, sensitive to light, and during exposure they undergo decomposition with the evolution of nitrogen gas. Ruff and Stein have prepared new azo-derivatives, and have to some extent traced the relation of constitution to greater or less sensitiveness; moreover, they have simplified the working of the diazotype printing process. Incidentally to the study of the carbazol,



a large quantity of the corresponding 3—amidocarbazol was prepared, and the corresponding diazocarbazol was found to be easy of preparation, by the usual methods, and also fairly stable; moreover, its compounds with phenols and amines proved permanent. All these circumstances pointed to the possibility of basing a practically useful printing process, on the employment of the diazo-derivative in question. Paper treated with a solution of the diazo-derivative is highly sensitive to light, and if exposed under a positive, it will give a positive, if developed with a solution of a suitable amine or phenol, the diazo-derivative being decomposed by the action of light. In practice the paper is sensitised, with a double compound of zinc chloride and the chloride of the diazol-derivative, a two per cent. solution being employed. The paper should be a well-sized photographic paper, hardened by means of form aldehyde (formalin). The exposure under the positive is continued until the subject appears bright bluish on a yellowish ground. A one per cent. and slightly alkaline solution of naphtol is used to develop the impression. In this solution the image becomes orange yellow, but a bath of dilute acetic acid changes the colour to a fine brown. It is scarcely necessary to say that by using other developing agents of the class indicated by Messrs. Green, Cross, and Bevan, a wide range of tone may be obtained. Following on the lines of the Feer process, Messrs. Ruff and Stein prepared the sodium salt of the sulphonic acid corresponding to the above-mentioned diazo-derivative. They made up a sensitising preparation, consisting of 2 grammes of this sodium salt and 2 grammes of α naphtol, dissolved in 100 c.c. of water. Paper sensitised with this liquid gives a brownish-red image (in this case a negative should be used), which image may be fixed by treatment with hot water, very weak soda solution, weak acetic acid, and finally cold water.

Possible variations of the above-mentioned methods are obviously very numerous, and those who are specially interested should consult the original paper. The chief general conclusions as to the influence of the constitution on the sensitiveness of aromatic azo-derivatives are as follows:—In the case of the para substituted class, the introduction of a negative element generally increases sensitiveness but chlorine appears to be an exception. The negative nitro group increases sensitiveness most when in the ortho-position, less in the para-position, and least in the meta-position. The positive methyl group has an analogous effect, but reversed; the sensitiveness being lessened. As a general rule, the sensitiveness of the diazo bodies increases with the number of atoms in the nucleus.

In regard to the purely scientific aspects of these researches, Messrs. Green, Cross, and Bevan have already shown that the sensitiveness of these compounds is much increased by association with the various colloids which can be used as printing surfaces: and with regard to the modern theory of electrolytic dissociation and the saline character of all photo-sensitive compounds hitherto used, a further study of these compounds may be expected to contribute to the advance of the theory of photographic action. As the range of these diazo effects increases it will be important to determine the gradation of sensitiveness in relation to the different parts of the spectrum, as done by the authors above named, in their investigation of the primuline process. It may also be remarked that in recent years, there has been a good deal of attention given to photo-chemical action, more especially in determining definite molecular changes by means of light action. There is undoubtedly now a quantity of material accumulated, which should prove attractive as a basis for arriving at more definite and quantitative measures of light energy.

AGAVE FIBRE INDUSTRY.

An article on this subject has lately been published in the *Madras Weekly Mail*, from which the following particulars are taken. Reference is made to a movement in the district of Anantapur:—

We read and hear so much from time to time of new textile industries being introduced or recommended for introduction into this country, and see, as a rule, proportionately so little being really and practically done, that it is positively refreshing to learn of aloe planting and the extracting of fibre therefrom on a commercial scale. Two years ago, an Agave Fibre Company was formed at Pawai, in the Bombay Presidency, and an area of 469 acres, 566 of which were occupied by a lake, were acquired for the purpose of carrying on the industry. It may be noted that this is not the first time that the Bombay Presidency has considered in a practical way the utilisation of agave fibre, for in 1878, under the auspices of the Government of Bombay, an experiment was undertaken for the manufacture of paper at the Girgaum Paper Mill, but the result was a failure.

Agave is the name given to a large and important genus of fibre-yielding plants, indigenous to Central America, chiefly to Mexico, and introduced into India, in all probability, by the Portuguese. They are commonly called American aloes, though botanically this is a misnomer. They take several years to reach the stage of florescence, and from the fact that, under adverse conditions, their development may be retarded from 10 to 50, or even 100 years, they are popularly called century plants. When about to flower, an axis is developed from the centre of the rosette of leaves, and rising at the rate of from 5 to 10 inches a day, it frequently attains a height of 20, 30, or even 50 feet. The plant then continues to flower from its sub-divisions for a month or more, and dies after seeding; but from the ground offshoots spring up to replace the plants that have perished. The leaves are thick, fleshy-toothed, and spiny, crowded on the apex of a short, erect, succulent stem. The genus *Fourcroya* is practically treated as a species of agave, all that can be said about it being applicable to agave fibre; and it should be noted, in this connection, that aloe fibre plants change their character when taken from one country to another, so varieties of the plant may, after all, belong to one and the same species. *Agave Americana*, which Dr. Watts treats more as an aloe fibre plant, since it seems probable that its name is popularly given to a series of species and varieties which yield allied fibres, is plentiful in many parts of India, being well distributed all over the Madras Presidency, where we find it extensively used for railway and other hedges. It is an exceptionally hardy plant, thriving, like the madar, in hot regions where scarcely anything else would grow, and being equally at home on the hills, under widely different climatic conditions. If planted at regular distances, with a ditch on one side, so as to carry off the excess of moisture, it will thrive under almost any temperature. It possesses several economic and therapeutic properties. The roots and leaves yield the fibre known as vegetable silk. The leaves are sometimes used as a poultice, and occasionally as fodder. The roots, owing to their medicinal qualities, are mixed with sarsaparilla. The flower sap yields a sour liquid which may be turned into beer, and, indeed, is employed for this purpose by the Spaniards. In America, the plant was, until recently, cultivated more for this sap than for any other of its products, but of late years its value has everywhere risen, principally owing to its splendid fibre. It is very largely cultivated for textile purposes in Mauritius, where the *Fourcroya* is said to be the variety principally, if not entirely, grown.

Agave is planted about five feet apart, with the furrows a similar distance from each other, so that about 2,000 plants could be grown to the acre. Cutting may commence when the plants are about 7 to 8 years old, when they are grown from seed, but if propagated from shoots, which is said to be the safest and cheapest method, they may be cut about 3 or 4 years after planting. For cultivating from shoots, young plants, a year or two old, should be put down at the commencement of the rainy season, and if they are intended for a plantation, the young shoots should be planted in rows ten feet apart, and five or six feet should be allowed between each plant in the rows. A gravelly or laterite soil is most suitable, while a damp and water-logged soil is death to the plant. No manure is needed, and once the planting has been completed, the soil need not be disturbed again; nevertheless, experiments have shown that the expressed juice of the leaves considerably helps forward the growth of the plants. According to some authorities, the leaves should not be cut before flowering and seeding, otherwise the fibres will be weak. Other authorities, however, declare that the fibre should be from leaves cut before the flower appears; the younger the leaves, the finer the fibre. After the leaves are cut, they are put, under one process, through a crushing machine which breaks the hard bark of the leaf and crushes out the juice. The leaves are then pounded on a smooth stone with a wooden mallet until all the bark and woody matter is removed. The fibre is then washed until the whole of the sap and dirt is cleared out of it. It is then dried in the sun, and is ready to be turned to textile uses. There are now more expeditious and satisfactory mechanical processes for separating the fibre. But it is by adopting a chemical process for the extraction of the fibre that a substance is obtainable which would be fine enough for spinning and weaving purposes, and the market value of which would be three or four times that obtained for the coarse fibre extracted mechanically.

Agave fibre is highly prized as a substance for the manufacture of paper, making a strong, tough, smooth paper, which even while unsized may be written upon without the ink running. So far, it is said that the fibre prepared in India is harsh and brittle, though of good colour, but this is doubtless chiefly due to the primitive modes of extraction. Experiments conducted in the Madras Presidency have shown that agave fibre stands a far greater strain than coir, *hibiscus cannabinus*, *sanseviera zeylanica*, and *gossypium herbaceum*, and was only inferior in resisting power to *crotalaria juncea* and *calotropis gigantea*.

Other species of agave are also coming into importance, *Agave sisalana*, which yields the sissal hemp of commerce, being in much favour. For cordage purposes, agave fibre has successfully held its own with most known fibres. As regards durability, tests instituted have shown that part of a coil which had been fixed to the anchor of a boat, and kept constantly under water for six months, appeared to have undergone no other alteration than European rope would have done under the same conditions. The agave thrives under unfavourable circumstances, and is found in many parts of India; wherefore it is possible to turn it into a great industry, the only essential being that plantations be within convenient reach of a sufficient water supply.

AUTOMOBILES IN THE SAHARA DESERT.

According to a recent report in an American publication, the automobile has invaded the desert of Sahara. Several Frenchmen have made trips recently through a large part of the waste country in Southern Algeria, with such success that the French Government has, it is said, officially undertaken a series of tests. Since France's desire for territory has impelled her to extend the boundaries of her African possessions far into the Sahara desert, the problem of keeping open lines of communication and supply has been most serious. At present, camels are used to transport the necessary goods and provisions from oasis to oasis, and to carry the mails. It is hoped now to change this. Camels can go about three days without water, although, to be kept in the best condition, they should have water every day. Their normal rate of travel is from three to five miles an hour, although the best dromedaries will make ten miles an hour, and keep it up for ten hours a day. With these limitations, the problem of communicating across the desert, between points over 300 miles apart, has been an extremely difficult one. And further to the south, where the oases are more remote, and the temperature often reaches 133 degrees, the task has been practically an impossibility. The experiments made have shown that gasoline automobiles can far outdo the camel as a means of transportation in dry countries. Trips of 500 miles in length can be accomplished without great difficulty. Twenty miles an hour are attained in many parts of the desert, and the best speed of the camels can be practically doubled anywhere. Besides this, high temperatures have no effect on the running of the machine, and the amount of goods that can be carried is largely in excess of a camel's load. In the desert of Sahara there are between 1,500,000 and 2,500,000 square miles. The exact extent of the waste of shifting sand is unknown. A part of it is now open to some degree of civilsation, through the long distance travelling powers of the camels. If the automobiles prove as great a success in the desert as the preliminary experiments promise, another large part of the desert will become tributory to civilized man.

Correspondence.

IDENTIFICATION OF WOOD.

I have no desire to cross swords with Sir George Birdwood on the merits and demerits of "scientific" *versus* "economic" botanists; it is a subject which never finishes until the editor interposes. My remark was in no sense a sneer, but rather a complaint.

Sir George Birdwood, however, is himself in error when he says that the word "'medullary' explains the 'plates' connecting the pith with the bark of trees," because with the exception of those present in the primary wood, they do *not* connect the pith with the bark (except in certain orders), and they have no single trait in common with the pith except the property of accumulating starch, &c. I do not like the word "parenchyma" any more than your correspondent does, and would gladly adopt a better word than "soft-tissue," which I use as a simple alternative, if one can be suggested which will meet all cases. As regards the term "annual ring," I cannot imagine any simpler expression, or one which more accurately expresses the idea, except it be "annual cylinder."

HERBERT STONE.

Little Hay-house, near Litchfield.
Dec. 21st, 1901.

MEETINGS OF THE SOCIETY.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, at Five o'clock, by SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, on "Photography and its Applications."

LECTURE I. — Photographic Optics — Pinhole Photography—The Lens: its Defects and their Correction—Instantaneous Photography—Movements of Animals, &c.—Photography by the Electric Spark—Flying Projectiles—Falling Drops—Sound Waves—Stellar Photography—Photography and the Spectroscope—Photography of the Unseen — Photography the Hand-maid of Science.

LECTURE II. — Photographic Chemistry — The Sensitive Surface—The Negative and its Development—Photographic Printing—Photography and the Printing Press—Reproduction of Colour by Photography — Photography in Colours — Miscellaneous Applications.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 30...London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. H. A. Kennedy, "The Empire at Work and Play." Lecture I.—"America."

TUESDAY, DEC. 31...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. J. A. Fleming, "Waves and Ripples in Water, Air and Æther." (Lecture II.)

WEDNESDAY, JAN. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Sir Henry Trueman Wood, "Photography and its Applications." (Lecture I.)

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. H. A. Kennedy, "The Empire at Work and Play." Lecture II.—"Africa and Australasia."

THURSDAY, JAN. 2...Royal, Burlington-house, W., 3 p.m. (Juvenile Lecture). Prof. J. A. Fleming, "Waves and Ripples in Water, Air, and Æther." (Lecture III.)

Civil and Mechanical, St. Ermin's Hotel, Caxton-street, S.W., 8 p.m. Mr. A. S. E. Ackermann, "Engineering Observations in 1901 in the United States of America."

FRIDAY, JAN. 3...London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lectures.) Mr. H. A. Kennedy, "The Empire at Work and Play." Lecture III.—"India and the Far East."

SATURDAY, JAN. 4...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. J. A. Fleming, "Waves and Ripples in Water, Air, and Æther." (Lecture IV.)

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FRIDAY, JANUARY 3, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Wednesday Afternoon, January 8, 1902, 5 p.m. (Juvenile Lecture).—Sir Henry Trueman Wood, M.A., Secretary of the Society, "Photography and its Applications." Second and Last Lecture.

Syllabus. — Photographic Chemistry — The Sensitive Surface—The Negative and its Development—Photographic Printing—Photography and the Printing Press—Reproduction of Colour by Photography — Photography in Colours — Miscellaneous Applications.

JUVENILE LECTURES.

The first of the two Juvenile Lectures was given at 5 p.m. on Wednesday, January 1st, by Sir Henry Trueman Wood, Secretary to the Society, the subject being "Photography and its Applications."

The first portion of the lecture was devoted to elementary photographic optics. The formation of images by light passing through a small aperture, such as a pin-hole, was first explained, and it was then shown how a lens produces in a different, though somewhat similar, manner a much more brilliant image. The faults of the photographic lens were next described and demonstrated by means of a very large and curious burning-glass, some 200 years old, possessing to a remarkable extent all the possible faults of a lens for photography. Thus it was shown that an uncorrected lens could not bring the rays to an accurate focus, in consequence of the fact that light of different colours was focussed at different distances from the lens, and also because each zone of the lens from the centre to the circumference has a focus of its own. The defect known as astigmatism was then explained, and it was shown that a lens, except for the rays falling directly upon it, will not give in the same plane sharp images of vertical and horizontal lines.

The uses of photography for scientific observation were then discussed, and the lecturer remarked that the special qualifications of photography for the purpose lay in the facts, first, that it gave an accurate and truthful record of any subject however complicated, or of any phenomenon however evanescent; secondly, the photographic plate could record much more rapidly than the human eye could see, and therefore successive stages of an operation, too rapid for human vision, could be separated, and movements of the most rapid nature thus analysed; thirdly, that the photographic plate had the power of storing up faint impressions, so that by receiving the radiations from a dimly illuminated object for a considerable length of time, it was able to detect objects far too feebly luminous for the human eye ever to perceive.

As regards objects in rapid motion, pictures could be taken by the use of a shutter, or by a sudden flash of light, or even, when the latter as ordinarily produced was too long, by the electric spark, the duration of which could be limited to a few millionths of a second. Each of these methods was experimentally demonstrated, the application of the electric spark to photography being shown by means of a Wimshurst machine. In further illustration, photographs were shown of men and animals in rapid movement, of flying projectiles, falling drops, air-waves, and other phenomena.

The value of photography in detecting objects too faint to be seen was specially illustrated by examples of stellar photography. It was not too much to say that the existence of uncounted millions of stars, which had never been seen and never could be seen by the eye, had been rendered evident by photographic means.

The best illustration of a complex subject rapidly rendered by photography was the spectrum, and in consequence of this all spectroscopic observations were now made by means of photography.

A large collection of pictures was shown and explained, in illustration of the various applications of photography to scientific purposes, including physics, astronomy, geography, surveying, meteorology, microscopy, mineralogy, geology, biology, zoology, botany, bacteriology, surgery, anthropology, &c.

A demonstration of the action of Röntgen rays was given, and at the conclusion of the lecture a flash-light photograph was taken of the audience.

The lecturer desires cordially to acknowledge the assistance he has received by the loan of apparatus, photographs, &c., used in illustration of the first lecture, from the following:—The Astronomer-Royal, Sir William de W. Abney, Sir William T. Thiselton-Dyer, Sir J. Norman Lockyer, Sir William Roberts-Austen, Dr. John Abercrombie, Mr. T. Bolas, Mr. C. V. Boys, Mr. W. Brooks, Mr. B. H. Brough, Mr. Francis Darwin, Mr. G. Davison, Mr. Jules Fuerst, Mr. Clinton Dent, Mr. C. P. Goerz, Mr. F. G. Hodsoll, Mr. Herbert Jackson, Dr. J. Scott Keltie, Mr. J. Bridges Lee, Mr. Andrew Pringle, Dr. D. H. Scott, Mr. James Wimshurst, Mr. Charters White, and the Councils of the Royal Geographical, Royal Meteorological, and Royal Microscopical Societies.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CONFECTIONERS' MATERIALS AND PROCESSES.

By William Jago, F.C.S., F.I.C.

Lecture II.—Delivered December 2nd, 1901.

Referring back to our last lecture for a moment, we there traced the evolution of flour confectionery from the flour itself to the "moistened" and aërated cake or other confection. Obviously, however, our task is as y t far from complete, since, although flour simply moistened, aërated, and baked, constitutes a very wholesome article of diet, it still falls far short of the more exigent demands of those requiring confectionery.

Made Rich by Fats.

The next step to be considered is that of enriching a cake, an operation which is performed by the addition and incorporation of fat. We have already seen how distinctive a type of dough results from the use of fat as a moistening agent instead of water or substances containing water. The short-bread dough shown you last week consisted essentially of flour, sugar, and butter, and you noticed how short and non-coherent the dough was, and how short also was the baked short-bread, and how rich in flavour and character. Let us at this stage inquire into the properties of bodies included under this general heading of fat.

Under this name are included a number of substances, both of animal and vegetable origin. The fats have various melting temperatures, and, speaking broadly, those which are solid at the ordinary temperature, are called "fats," while those, which under this condition are liquid, receive the name of "oils." Pure fats and oils are usually either colourless or of a faint yellow tinge, while some of vegetable origin possess a green tint, derived from green vegetable colouring matter. Many fats and oils possess a distinct smell and taste, agreeable or otherwise, and indicative of their origin; such characters appertain, however, to minute traces of associated impurities, rather than to the pure fat and oil itself. Consequently, the act of refining and purifying oils generally tend to deprive them of special flavour, leaving behind a bland and almost tasteless body. All ordinary fats and oils possess the property of "greasiness;" if dropped in the liquid state on paper or cloth, they produce a grease spot, and give that well-known "slipperiness," so characteristic of a greased surface. This peculiar property leads to a most extensive employment of these bodies for lubricating purposes, a use which lies outside the scope of the present lectures.

Oils and fats are practically insoluble in water, somewhat soluble in absolute alcohol, or even strong spirit, especially when hot. Ether, chloroform, and other somewhat similar substances dissolve them readily; so also the various oils and fats are readily soluble in each other, and consequently may easily be mixed in all proportions. Viewed themselves as solvents, they have practically no action on most of the substances employed by the confectioner. Thus the constituents of flour are not dissolved by oil, and this is the reason of the particular "shortness" of flour mixtures, such as the short-bread dough just shown you, into which any fat has largely entered. Oil dissolves some colouring matter, and also flavourings, so that these amalgamate somewhat readily with the fatty part of various mixtures.

Fat and oils, if preserved from the atmosphere, remain unchanged for a considerable time, but on exposure are liable to acquire the property of rancidity. This is much hastened by the presence of impurities resulting from imperfect separation from the animal or vegetable source of origin. Natural fats may be viewed as compounds of the higher fatty acids with glycerin, or some closely allied body. Among the fatty acids most frequently occurring are those of the stearic series, represented by the general formula $HC_nH_{2n-1}O_2$, and the oleic series represented by $HC_nH_{2n-3}O_2$. Thus mutton fat is largely composed of stearate of glycerin, which body may be artificially produced by heating together glycerin and stearic acid thus,

$$\underset{\text{Stearic acid.}}{3HC_{18}H_{35}O_2} + \underset{\text{Glycerin.}}{C_3H_5(HO)_3} =$$

$$\underset{\text{Glycerin stearate.}}{C_3H_5(C_{18}H_{35}O_2)_3} + \underset{\text{Water.}}{3H_2O.}$$

This body, glycerin stearate, is conveniently called "stearin."

Olive, and lard oils consist largely on the other hand of glycerin oleate: the formula of oleic acid is $HC_{18}H_{33}O_2$, and the oleate is consequently $C_3H_5(C_{18}H_{33}O_2)_3$. This body has received the name of "olein."

Stearin is a somewhat hard solid, while olein is liquid at ordinary temperatures; as may be surmised, therefore, stearin and allied bodies are more largely found in fats, while oils consist principally of olein and its congeners.

Melting and Solidifying Points. — The temperatures at which these changes occur are of considerable importance in the selection of fats for different purposes, a fat when once melted remains liquid at a considerably lower temperature than that required for the act of fusion. Thus mutton fat melts at a temperature ranging between 46·5 and 47·4° C; but when once melted only re-solidifies at a temperature of from 32 to 36° C. In the Table following later, the temperatures of solidification are given. At temperatures varying from 250° C. (482° F.) to 300° C. (572° F.), fats are decomposed, yielding various products of a disagreeable odour.

Specific Gravity of Fats.—These bodies are all of them lighter than water, the specific gravity varying between 875 and 970, water being taken at 1,000. The specific gravity is a valuable means of identifying and distinguishing fats, and consequently has been determined with considerable care. As the oils are liquid at ordinary temperature, and the fats solid, it is preferable to select some temperature at which all are in the liquid state. That found most generally convenient is the temperature caused by immersion in boiling water, and this in practice registers at 99° C. The figures given in the subsequent Table have been taken at this temperature; they are somewhat abnormal, as they give the specific gravity of the fats at 99° C. compared with water at 15·5° C.

Chemical Constants of Fats.—There are various data used by the chemist in recognising different fats, and detecting adulterations. Among these are the following:—

"Iodine Value."—This term is applied to a most important determination now made on fats as the result of investigations by Hubl. If any fat or oil be dissolved in chloroform, and then an excess of a solution of iodine and mercury chloride in alcohol added, absorption of the iodine by the fatty matter proceeds. Using proper precautions, the amount of iodine thus absorbed is capable of very exact measurements, and the figure thus obtained is that quoted as the "iodine value." Thus, if the iodine value of a fat is given as 50, this means that under the standard conditions of what is known as Hubl's test, 100 parts of that fat absorb 50 parts of iodine. The iodine value not only throws light on the probable nature of an oil or fat, but also, in many instances, affords valuable indications of the purity and quality of the fat in question. Speaking generally, the more oily a fat, the higher is its iodine value.

"Reichert-Meissl Value." — Fats have already been referred to as compounds of fatty acids. Of this group of bodies some are readily volatile at the temperature of boiling water, while others are non-volatile under the same conditions. Butter fat is distinguished from almost all other fats by containing a high proportion of such volatile acids. The exact determination of the volatile acids in a fat, is a work of tediousness and some difficulty. But under standard conditions, a fairly constant fraction of such volatile acids can be obtained and determined, and this constitutes a test of considerable importance. A weighed quantity, five grams of the fat, is made into a soap, by treatment with excess of potash; on adding excess of sulphuric acid, this soap is decomposed, and the whole of the fatty acids liberated. The solution is altogether diluted with water, to 140 cubic centimetres, and then distilled until 110 cubic centimetres of the distilled liquid have been collected. The acidity of such filtered distillate is then determined by the use of phenolphtholein and decinormal potash solution. Such acidity is termed the Reichert-Meissl value. Thus, if five grams of butter fat gave a distillate, which took thirty cubic centimetres of decinormal potash to render it neutral, then the Reichert-Meissl value of such fat would be said to be thirty.

This figure is evidently the measure of the quantity of volatile acid which distils over under certain standard conditions.

"Butyro-Refractometer Value."—Like other transparent substances, melted fats have a refractive action on a ray of light passing obliquely through a layer of them. The amount of such refraction is fairly constant for some fats, but varies however with the temperature. The instrument known as Zeiss' butyro-refractometer is one for rapidly measuring the amount of such refraction. On looking through the optical portion of such an instrument, the point of refraction is shown by means of a scale, and and can be read off at once into degrees, which we will, for example, call 47°. The instrument is also provided with a thermometer, graduating into arbitrary degrees, and this is also read at the same time as the point of refraction of the fat. Suppose that this figure is also 47°; then in the case of a butter for which this determination is principally used, the difference between the two is 0°, and such butter fat is at the bottom limit of an arbitrary scale of purity. If the reading on the butter fat is lower than that of the thermometer, then the butter so far as this test goes is passed as pure: if higher, then the butter is suspicious, and requires to be further and more systematically tested. The following figures were obtained during actual examination of various butters:—

Butter reading,	46·4	44·0	50·0	52·5
Thermometer reading,	47·0	45·9	47·1	47·1
	−0·6	−1·9	+2·9	+5·4

Of these tests, the two former were pure butters, the third was a margarine, and the fourth a beef-fat preparation. By means of the arbitrarily marked thermometer, the disturbing influence of temperature is eliminated, as minus results indicate purity of butter fat, and plus results impurity. Otherwise it becomes necessary to give both the butter readings and the temperature of the fat when it was taken, after which such readings must be calculated and connected to a given temperature. Thus at 25° C., genuine butters have a range of from 49·5 to 54·0°, and margarines of from 58·6 to 66·4°.

Tabular Description of Oils and Fats.—In the following Table particulars are given of the various fats and oils either directly used by the confectioner or indirectly as component parts of various butter substitutes or other confectioners' fats. For these data and their arrangement, the writer is indebted to "Allen's Commercial and Organic Analysis," and "Lewkowitsch's Analysis of Oils and Fats." (See p. 109.)

Butter.—There can be little doubt that where prime cost is no object, butter is by far the best and most pleasant fat to be used for the great majority, if not all, of confectioners' purposes. Substitutes for butter will succeed or fail according to the degree in which they reproduce and possess the characteristics of good butter. Butter is, therefore, first described, and other substances which follow are naturally compared with and tested against butter as a standard.

Butter may be defined as the substance produced by churning the cream derived from milk. During this process the fat globules coalesce, and after washing and other treatment, result in the production of butter.

For several reasons a subject of interest is the sources from which our butter supply is derived. Butter is, of course, manufactured in England; but probably in the United Kingdom, Ireland with its rich pasture lands holds the premier position as a producer of butter. Excellent butter of the highest class comes to us from the Normandy districts of France. Denmark also supplies butter in very considerable quantities, while comparatively recently Siberia has come as a seller into the butter market. Last, but not least, among those who help to fill John Bull's capacious larder with butter are the colonies and other dependencies. Canada, Australia, and New Zealand, are all of them large exporters of butter to the mother country. Through the courtesy of the various colonial representatives in this country, I have been supplied with samples of colonial butter, to which, among others, your attention will shortly be directed. While seeking these I had the pleasure of meeting Mr. H. C. Cameron, the energetic Produce Commissioner of New Zealand. That gentleman not only procured for me a number of samples, but also supplied me with a most extensive range of literature, dealing with the butter and dairying industry of that country. Particulars of the legislation for, and organisation of the New Zealand dairy enterprise are of interest, not only in themselves, but as a guide and example to less progressive communities. For that reason they merit some further description. In 1898 an Act was passed by the General Assembly of New Zealand, in order to regulate the inspection of Dairies and the Manufacture, Inspection, Sale and Export

PROPERTIES OF OILS AND FATS.

Kind of Oil or Fat.	Source.	Specific Gravity at 99° C.	Solidifying Point °F.	Iodine Value.	Reichert-Meissl Value.	Butyro-refractometer Value at 25° C.	General Properties.
Olive oil.	Fruit of olive	861·5	21 to 39	83·0	0·6	62·4	Pleasant flavour; easily turns rancid.
Almond oil	Nuts of almond	919 at 15°C	− 4 to + 14	98·4	—	64·4	Bland, agreeable taste.
Earth nut oil	Nuts of arachis	867·3	23	103	—	65·8	Yellow, or nearly colourless; pleasant nutty flavour. Used as adulterant of olive and lard oils, and in margarines.
Cotton seed oil	—	872·5	34 to 50	1 6	—	68	When refined, of straw or golden yellow colour. Bland, agreeable taste. Used in margarine and butter substitutes.
Maize oil	Maize germ.	—	− 4 to + 14	115	0·66	—	Yellow; thicker than olive oil.
Sesamé oil	Seeds of sesamum	867 9	21 to 25	106	1·2	68	Pale yellow, odourless, agreeable taste. Used in margarine.
Hazelnut oil	Nuts of hazel	—	− 2 to + 14	86	0·99	—	Light yellow; mild, sweet taste, somewhat resembles butter. No marked smell. Soon becomes rancid.
Lard oil...	Obtained by pressing lard	—	25 to 50	67 to 82	—	—	Very slightly coloured; slight odour of lard.
Poppy-seed oil	—	873·8	− 18	138	—	73	Straw yellow, limpid, odourless; much resembles olive oil.
			Melting point.				
Cacao butter	Nuts of theobroma	857·7	86 to 93	34·3	3 2	47 at 40°C.	Colourless; chocolate-like taste and smell. Not liable to rancidity.
Nutmeg butter	—	898	77 to 93	41·5	—	—	Taste and odour of nutmeg.
Shea butter	—	859	73 to 110	56·5	—	—	Faint cacao-like odour and agreeable flavour.
Cotton seed stearin	From cotton seed oil	858·4	70 to 104	89	—	—	Resembles tallow; used for adulterating lard and in margarine.
Cocoanut oil	Nuts of cocos	873·6	68 to 82	8·7	7·5	35·5 at 40°C.	White, or slightly coloured; tastes of cocoanut; readily turns rancid.
Tallow: suet	From the ox or sheep	862·6	97 to 120	35 to 40	0·5	49 at 40°C.	Melting point varies with part and nature of animal from which derived.
Lard	From abdomen and other parts of the hog.	860·8	83 to 113	46 to 63	Below 1·0	56 to 58 at 25°C. 45 to 53 at 40°C.	Melting point varies much with part of animal from which derived. Used in butter substitutes.
Horse fat	From the horse	861	93 to 129	71 to 86	1·6 to 2·1	53·7 at 40°C.	Yellow or dirty white to brown, consistency of lard, or harder. Said to be used in butter substitutes.
Butter fat	Cow's milk...	867·7	84 to 95	26 to 35	24 to 33	49·5 to 52·5 at 25°C. 41 to 44 at 40°C	Yellow; pleasant taste and smell.
Margarine	Hog's fat, mixed with beef or mutton stearin, cocoanut oil, cotton seed oil, &c.	859·2	93 to 104	48 to 55	1·1 to 2·2	48·6 to 49 at 40°C.	Closely resembles butter, with which it is frequently mixed.

of Dairy Produce. Under powers granted by this Act, Inspectors are appointed with almost plenary powers. Such inspectors may, practically, at all times, inspect dairies, dairy produce, and open for that purpose all packages supposed to contain dairy produce. In any case where the inspector is satisfied of any defects he may order such to be remedied to his satisfaction. Further, he is required to condemn any dairy produce whenever he is satisfied that such produce is unfit for human consumption. As part of the conditions of sale of dairy produce, it is enacted that no person shall export, or attempt to export, any dairy produce which for any reason is likely to endanger the public health. These most stringent provisions give the inspectors almost autocratic powers; but, in addition to the duty of thus rigorously treating the evils of bad dairying, they, and other officers, also fulfil the function of helping in every way and stimulating the production of butter and other dairy produce of the highest class. Thus, there is a Dairy Commissioner, Mr. J. A. Ruddick, with whom is associated a staff of graders and instructors. An important part of the duties of these officials consists in giving practical instruction in the work of butter and cheese making at the various factories. Among the subjects on which information has been given are the following:—Milk testing at factories; should milk be pasteurised? pure cultures for starting lactic fermentation of milk; should separation be done at the farm or the factory? and other topics of most direct and valuable interest to all concerned in the trade. All butter for export purposes is graded by the State, which, in the first place, classifies and keeps a register of all dairies. The Government provides cold storage rooms, at specified ports, in which the latter is deposited while awaiting shipment. The graders, who are as a rule picked dairy factory managers, examine each parcel, and give points on the following scale, for creamery butter:—

	Points.
Flavour	50
Body, moisture, texture	25
Colour	10
Salting	10
Finish	5
	100

Butter is placed in the first grade, which secures 88 points and over; in the second grade, under 88 points, and over 80 points; and in the third grade, with 80 points and under. Of creamery butters examined and graded in 1899-1900, the following results were obtained:—

First grade	92·63 per cent.
Second grade	7·10 ,,
Third grade	0·27 ,,

Another part of the duties of the port graders is to inspect the cold storage accommodation of ships, and in this way to do all they can to see that such produce has a good send off from colonial shores. Its well being in this country is attended to by the produce commissioner, who sees that all is well on arrival here, notes critically any defects, and reports them to New Zealand for remedying in the future. I have thought it well to thus explain in detail the organised precautions taken to ensure for us a supply of the finest possible colonial butter.

Having now obtained our butter in the manufactured state, it will be well to inquire somewhat into its nature and character. However well and carefully made, butter contains a good deal else than pure fat; among such other matters being water, proteids, and milk-sugar—usually classed together in analysis as curd, traces of natural mineral matter, and more or less added salt. For confectioners' purposes the water is totally useless; or at any rate, can be obtained from the most exorbitant water company at an appreciably lower rate than the cost of butter. The presence of large quantities of curd in butters is general evidence of inefficient manufacture, and excess of proteid matters by their rapid alteration confer an unpleasant cheesy taste. Salt is added as a preservative, and also as a flavouring agent; but as such is of no service to the confectioner, who, as a matter of fact, when using a salt butter will usually wash the salt out as completely as possible as a preliminary to its employment. We are then reduced to the fat, and practically that is the substance in butter of value: everything else being equal, the greater the proportion of fat the more valuable is the butter.

A reference to the Table already given will show that butter differs from every other fat quoted in the very high Reichert-Meissl value it possesses. As already explained, this figure is an indication of the amount of volatile fatty acids present. These substances give butter those characteristic properties not exhibited by any other fat. Therefore, the determination of Reichert-Meissl value is, in the case of butters, a most important estimation. In the following Table is given the result of analysis of various typical butters which, except when otherwise stated, have been made by the lecturer:—

ANALYSIS OF SAMPLES OF BUTTER AND MARGARINE.

No.	Mark or Description.	
1.	English, analysis by Richmond.	
2.	German, salt, ,, ,,	
3.	Danish, salt, ,, ,,	
4.	Swedish, salt, ,, ,,	
5.	Australian, salt ,, ,,	
6.	Danish,	Samples forwarded by Messrs. Lovell and Christmas (Limited).
7.	Normandy, fresh,	
8.	Normandy, salt,	
9.	Canadian (I.),	
10.	Canadian (II.),	
11.	Australian,	
12.	New Zealand,	
13.	Irish, lowest in water of nine samples.	

14. Irish, average of nine samples.
15. Irish, highest in water of nine samples.
16. Siberian, lowest in water of ten samples.
17. Siberian, average of ten samples.
18. Siberian, highest in water of ten samples.
19. New season New Zealand, lowest in water of nine samples.
20. New season New Zealand, average of nine samples.
21. New season New Zealand, highest in water of nine samples.
22. Margarine, with admixture of butter.
23. Margarine (II)., ,, ,,
24. Margarine (III.), without butter.

No.	Water.	Salt.	Curd (chiefly casein).	Fat.	Total.	Value in percentage of "Standard."	Reichert-Meissl value.	Butyro-refractometer value.
1	11·6	1·0	0·6	86·8	100·0	89·6	..	..
2	12·3	1·3	1·2	85·2	100·0	97·9	..	..
3	13·4	1·9	1·3	83·4	100·0	95·8	..	..
4	13·8	2·0	1·3	82·9	100·0	95·3	..	..
5	12·7	1·6	1·2	84·5	100·0	97·0	..	..
6	12·4	1·4	0·6	85·6	100·0	98·3	32·3	— 1·9
7	12·4	0·0	1·7	85·9	100·0	98·7	31·1	— 1·2
8	10·6	1·4	0·8	87·2	100·0	100·2	31·1	— 1·0
9	9·7	1·5	0·6	88·2	100·0	101·3	28·6	— 0·05
10	8·2	1·7	0·3	89·8	100·0	103·3	28·9	+ 1·1
11	11·8	3·4	0·4	84·4	100·0	97·0	31·0	— 1·2
12	9·1	2·8	0·5	87·6	100·0	100·6	29·8	— 0·2
13	14·5	4·6	0·9	80·0	100·0	91·9	30·8	..
14	16·7	6·2	1·1	76·0	100·0	87·3	31·1	..
15	19·8	7·1	1·0	72·1	100·0	82·8	31·6	..
16	9·4	1·0	0·8	88·8	100·0	102·0	27·1	..
17	10·3	1·4	1·1	87·2	100·0	100·2	26·7	— 0·5
18	11·3	1·2	1·2	86·3	100·0	99·1	26·9	..
19	7·2	1·2	0·4	91·2	100·0	104·8	31·9	— 0·2
20	7·6	1·2	0·4	90·8	100·0	104·3	..	..
21	8·1	0·9	0·3	90·7	100·0	104·1	30·4	+ 0·9
22	13·2	1·7	3·0	82·1	100·0	94·3	5·7	+ 2·9
23	7·7	1·7	0·7	89·9	100·0	103·1	4·0	..
24	6·7	2·3	0·2	90·8	100·0	104·2	0·8	+ 5·4

Samples Nos. 6 to 12 are described as fair average samples, and not in any way picked or choicest butters of their kinds. Looking at the whole series, the New Zealand butters are characterised by containing the lowest percentage of water, and highest of butter fat. The Canadians and Australians also are very low in water, while next follow the Siberian samples. The Irish butters are marked by a large percentage, both of water and salt. One of the data given, it will be noticed, is the value in percentage of "Standard." Taking these butters right through, it was found that many samples contained 87 per cent., or over, of butter fat. This figure 87 was accordingly taken as a standard for butter. In the following Table is given, in column two, the value, in terms of the standard, of butters containing various percentages of fat. Also it is shown in column three, how many pounds of the butter are required to yield the same amount of fat, as do 100 pounds of the standard butter. (See Table, p. 112.)

Thus supposing that a butter has only 72 per cent. of fat, then everything else being equal, it is only worth 82·7 per cent. of butter of standard composition. Further, in use 120·8 lbs. of that butter are required to go so far in fat as do 100 lbs. of the standard. Taking on the other hand a butter with 92 per cent. of fat, such butter is worth 105·7 per cent. of standard, and in use 94·5 lbs. only are required to go so far as 100 lbs. of the standard.

The Reichert-Meissl value of the butters varies from about 26 to over 31; the whole of these figures being within the recognised limits of purity. But evidently a butter with a value of 31 must be richer in volatile acids than is one with 26, and will be found, if one may coin the term, to be the more "buttery" butter of the two. In confectioners' valuation of butters, a high Reichert-Meissl value is of importance since the fulness of butter flavour indicated will enable such a butter to be mixed with a considerable proportion by a neutral character fat, such as lard, and yet be as "buttery" in character as another butter containing normally a low proportion of volatile fatty acids.

VALUATION OF BUTTERS.

Percentage of Fat.	Value in Terms of Standurd.	Quantity containing same weight of Fat as 100 lbs. of Standard.
70	80·4	124·3
71	81·6	122·5
72	82·7	120·8
73	83·9	119·1
74	85·0	117·5
75	86·2	116·0
76	87·3	114·4
77	88·5	112·9
78	89·6	111·5
79	90·8	110·1
80	91·9	108·7
81	93·1	107·4
82	94·2	106·0
83	95·4	104·8
84	96·5	103·5
85	97·7	102·3
86	98·8	101·1
87	100·0	100·0
88	101·1	98·8
89	102·3	97·7
90	103·4	96·6
91	104·6	95·6
92	105·7	94·5
93	106·8	93·5
94	108·0	92·5
95	109·2	91·5

An inquiry naturally arises as to what qualities of butter are required by the confectioner. A glance at the goods he produces gives almost of itself an answer to the question. They range from cakes of the most expensive character, priced at many pounds each, to those sold at a figure but little exceeding the price of bread. With such a range of qualities, fat from the best quality butter obtainable to the very cheapest of wholesome fats are found of use, and so one cannot pick out any special quality of butter and designate it confectioner's butter. For certain purposes, the demands of the confectioner are more critical than those of the breakfast table, but these requirements are, it must be admitted, limited in scope. The confectioner is, after all, but the servant of the public, and with an educated demand for articles of the best quality, is prepared to obtain raw materials of the highest character, in order to supply them. With a general improvement in the quality of butters, higher and better grades should come within the reach of the confectioner, and this in turn should react to the advantage of the ultimate consumer.

In working butters, there is one point which may always be noted. Some butters are defined as weak, while others are strong and waxy. The former, on warming, readily become oily, while the latter remain tough and wiry. If paste be made from the former, the paste does not rise well, while the melted fat drains readily from the hot goods. The tougher butters make lighter paste, and are more fully retained by the articles when baking.

Occasionally one meets with a sample of butter of a decidedly fishy flavour. In some cases this is apparently due to cattle being fed more or less on fishy matters. This however, can scarcely be the whole explanation, since fishy butters are at times found when cattle having an access to fish is an impossibility. It is well known that herring brine in decomposing, yields the substitution ammonia, methylamine; and under some conditions of uncleanliness, the proteids of butter may undergo a somewhat analogous change with the formation of similar bye-products.

A word may here be said as to rancidity in butters; and on this point some interesting data are given by Lewkowitsch, of which the following is a summary. When kept under unfavourable conditions, butter acquires a strong acid and unpleasant flavour, to which the name of rancidity is given. At the same time, some decomposition of the fat goes on, and some of the fatty acids are liberated in the free state. This alone does not, however, produce rancidity, since the addition of free fatty acid to an oil does not impart a rancid character, although it gives the oil a sharp taste. It has been surmised that bacteria are responsible for the production of rancidity, but this has been disproved. Neither is the presence of moisture necessary, since dried fats are more liable to this change than those containing a certain amount of moisture. Rancidity must therefore be considered due to direct oxidation by the oxygen of the air, this action being itensified by exposure to light. Both oxygen and light must act simultaneously, in order to produce rancidity, either of these agents alone being unable to cause any alteration in that respect. Solid fats, especially those of animal origin, are less liable to turn rancid than liquid fats. With an indication of the causes of rancidity, the means of prevention will suggest themselves to the user of fats.

Prior to use in confectionery, butter is usually "creamed:" in this operation the butter is beaten until of the consistency of cream. The operation is hastened by slightly warming, although except in very cold weather such is not absolutely necessary. This act of creaming consists of breaking down the butter into an emulsion in which both the fat and the water exist in minute globules.

From butters we must proceed to pass other animal fats in rapid review.

Beef Fat.—This is sometimes found in the well known form of dripping, but does not by itself, reach the confectioner in any great quantity. When the very fatty portions of the carcase are heated, the fat melts, and separates from the containing tissues, and in this way a pure beef fat may be obtained. Like many other animal fats—that of beef is a mixture of a harder and a softer portion. If the fat be gently heated, the softer part becomes liquid, while the harder part still retains its solidity. The fat in this condition may be enclosed in canvas bags, and subjected to pressure: the more liquid portion passes through and constitutes a body known in commerce as "oleo," while the harder part remains behind, and commercially, is termed beef stearin. Samples of these are before you, and must be returned to presently.

Hog Lard.—Lard is obtained from the fat of the pig in much the same way as beef fat from that of the ox. Lard is a white fat of somewhat pleasant taste and a soft consistency. Like beef fat, it may be separated by warmth and pressure into lard stearin, and lard oil. The fat of some portions of the pig is much harder than the others, consequently, some of the fat of the abdomen, if melted down separately, gives a much harder lard than do other parts, or than would be yielded by the fat of the whole animal. The harder lards are found to contain a larger proportion of stearin than do those of softer nature. In summer and very hot weather, there is considerable difficulty in cooking with the softer lards, which become almost liquid. In order to get over this, such lards may be fortified by the addition of stearin of either lard or beef fat. Given a soft whole hog lard, there can be little doubt that its cooking properties are improved by the addition of stearin, while certainly the wholesomeness is in no way deteriorated. The only point is, that a purchaser who gives the price for the more expensive lard, derived from the harder parts of the pig, has a right to expect to obtain the same, and not a soft whole lard, hardened by some foreign fat. Lards are, at the present time, almost pure fats; they melt into a liquid, which is either perfectly clear, or only slightly turbid through the presence of a scarcely weighable quantity of unseparated tissue. The chemist, in analysing lard, directs his attention principally to the detection of foreign fats or oils. In doing this, the iodine value is of much assistance to him; the harder fats, as beef stearin, having a lower value than lard, while most oils have a much higher value. The difficulty here is that a mixture of beef stearin and oil may be so arranged as to have the same iodine value as pure lard. The microscope is called into requisition in order to detect the addition of stearin, since in samples of lard dissolved in ether, and then allowed to recrystallise out, the crystals from beef stearin differ in appearance from those of lard in a state of purity. These crystals are not only microscopically examined, but also separated and weighed. Unfortunately, these tests at times fail to distinguish between added stearin, and natural lards in themselves containing stearin in excessive quantities. Under such circumstances the decision as to the presence or not of an adulterant becomes a difficult one.

Vegetable Fats and Oils.—These have been already indicated, though very briefly, in the Table given at an earlier stage of this lecture. But few of these are used alone, the most frequent employment of the oils being in conjunction with various animal fats. Among the solid vegetable fats are cacao-butter, which is natural fat of cocoa or chocolate. This will be touched on when dealing with chocolate and its manufacture, in a subsequent lecture.

The so-called cocoa-nut oil is, in reality, not a liquid, but a solid, and is characterised by possessing a somewhat low melting point, and yet being a rather hard fat. In its natural state this fat is said to readily become rancid: the thoroughly purified forms are certainly free from this very serious defect. In various forms this product is now one of considerable importance, and accordingly, I have asked Messrs. Loders and Nucoline, Limited, to furnish samples for your inspection which are here before you. In preparing these from the crude cocoanut fat, the fat is melted in a vacuum, and then a current of low pressure steam forced through. This butter carries off volatile substances of objectionable or pronounced odour or flavour, and leaves behind a pure and comparatively neutral fat. Like the lards, these preparations are pure fats, and contain no foreign matter. They are distinguished from other fats, both vegetable and animal (except butter), by possessing a rather high Reichert-Meissl value.

So far, we have been dealing with types of fat which, whether of animal or vegetable origin, each come from a distinct and well known source. We will next turn our attention to compound fats which are manufactured either as substitutes for butter, or as compounds which, while not claiming to be substitutes for any other fat, are mixtures which are more generally suitable for confectioners' use than would be their constituents taken separately.

First, and most important among these, are what have been called artificial butters. In 1870 the French chemist, Mége-Mouries, first described a method of making artificial butter on the large scale. Since then his methods have been considerably developed, and a large industry has developed in what were formerly termed artificial butters, butterine, oleo-margarine, and now by legal enactment, "margarine." The basis of the modern methods of preparing this article consists in first rendering fat of the ox; this, after melting, is drawn off from solid impurities, and allowed to cool very slowly. During this process the more solid portion of the fat crystallises out as stearin, and is removed by filtration under pressure. The liquid portion solidifies into a granular solid of a slightly yellow colour, to which the name of "oleo" is given. Lard is also prepared in somewhat the same way, and to this the name of "neutral," or neutral lard, is applied. These two substances constitute the basis of margarine. The oleo being the harder fat of the two, is taken in larger quantity for margarine exposed to a warmer climate. The mixed oleo and neutral are next agitated with milk or cream, or possibly butter added, and thus the necessary flavour introduced. During the same operation, an amount of butter colour is incorporated, sufficient to produce a tint resembling that ot butter itself. Different manufacturers use, in addition to these ingredients, various vegetable oils, in order to soften the products, and thus render them more adopted to general purposes. Arachis, sesamé and other oils are thus employed, and examples are before you. The Craigmillar Creamery Co. has kindly supplied me with samples of their raw materials, and also finished products, for your inspection. When properly made, there can be no doubt as to the wholesomeness and nutritive value of these artificial butters. The conditions of manufacture are usually hygienic, the materials being obtained in a fresh state and sterilised before use. The composition of margarine is shown in the last three analyses quoted in the Table of butters before given. The fat value is generally high, while a clear line of distinction between these substances and butter is afforded by the low Reichert-Meissl and high butyro-refractometer values. The former, in the case of No. 24, falls below 1·0, while in the admixtures of margarine and butter the figures of 4·0 and 5·7 respectively were obtained. At one time mixtures were offered to confectioners stated to contain anything up to 40 per cent. of butter; now, by law, the proportion of butter permitted to be added to margarine is restricted to 10 per cent.

Compound lards are yet another form of mixed fats; these are sold both under that name and also at times as pure lards. Their basis is usually beef stearin, or whole beef fat, mixed with vegetable oil, generally cotton-seed oil. With these more or less lard may also be incorporated. As lard is generally checked by its iodine value, these mixtures, if intended as fraudulent lard substitutes, require to be made so that their iodine value is the same as pure lard. Specimens of various such mixtures are before you.

It is not too much to say that both the animal and vegetable kingdoms have been thoroughly exploited in order to find fats for the confectioner. One may go a step further, and say that the mineral kingdom has also been laid under contribution. There is a class of bodies known as paraffins, the higher members of which are, when pure, white, solid, tasteless waxes. A specimen of such paraffin is before you. Then next, another substance has been prepared, known sometimes as soft paraffin, and also as vaseline. This latter, which is also tasteless and odourless, has a soft and semi-buttery consistency. Its physical nature is very like that of the fats generally, but it differs in that it is unattacked, even by strong alkalis, and so cannot be converted into soap. It is therefore matter for little surprise that vaseline, paraffin, and petroleum products generally are entirely unassimilable by the human digestive system, and therefore absolutely devoid of nutritive value. When a person buys a cake, these mineral bodies are certainly not of the nature, substance, and quality of the article demanded by such purchaser. While as food these substances are perfectly valueless, the lecturer is not aware of their possessing any positively harmful qualities. It would seem probable that, according to the extent to which flour and other bodies were saturated with paraffin, they would thus be protected from digestive action within the alimentary tract, and thus they would be rendered more difficult of digestion and of less food value.

MADE SWEET BY SUGAR.

In the next place, most forms of cakes and pastry are made sweet. For this purpose cane sugar is that most frequently used, and in one or other of its commercial forms is added to various cake mixtures. In ginger-bread, and a few other confections, treacle or syrup is used as the sweetening agent. This is the residual substance remaining when as much as possible of the crystallisable sugar has been obtained in the solid state. Honey is also, although but rarely, used by the confectioner for sweetening purposes. Malt extract is essentially a mixture of dextrin and maltose; it also receives a limited application as a sweetening agent. The sugars form a comparatively small proportion of cakes and flour confectionery. They form, on the contrary, the basis, and by far the larger portion of the material of the sugar confectioner. For this reason the full discussion of the sugars must be postponed until dealing with sugar confectionery in our next lecture.

[The lecture was followed by a demonstration of piping and other cake ornamentation, organised and given by Clark's Bread Company (Limited), of Brighton. That firm also specially made the various cakes and other goods used in illustration of the lecture.]

Obituary.

SIR HENRY GILBERT, F.R.S.—Sir H. Gilbert, the distinguished agricultural chemist and life-long colleague of the late Sir John Bennet Lawes in the Rothamsted agricultural experiments, died on Monday, December 23rd, at his residence at Harpenden, St. Albans. Joseph Henry Gilbert, son of the Rev. Joseph Gilbert, and his wife Ann Taylor, of Ongar, was born at Hull in 1817. He studied in the laboratory of Professor Thomas Thomson at Glasgow University, and then proceeded to University College, London, where he attended the lectures of Professor Thomas Graham, and worked in the laboratory of Dr. Antony Todd Thomson, where J. B. Lawes, three years' Gilbert's senior, was also a pupil. He next went to the University of Giessen, to study chemistry, under Liebig, and there he took the degree of Ph. D. In 1843, Gilbert, at the age of twenty-six, became associated with Lawes, and assumed control of the chemical laboratory at the Rothamsted experimental station, Harpenden. The collaboration of these two pioneers in the field of scientific agricultural research lasted for fifty-seven years, and was only terminated by the death of Sir John Lawes on August 31st, 1900.

Sir Henry Gilbert was elected a member of the Society of Arts in 1855; and in 1893 the Albert gold medal was awarded to Sir John Lawes, and a like medal to Dr. Gilbert, "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted." These medals were presented to the two recipients on February 23rd, 1894, by H.R.H. the Prince of Wales (President of the Society) at Marlborough House. In 1893 Dr. Gilbert received the honour of knighthood.

MATTHEW GRAY.—Mr. Matthew Gray, for many years managing director of the India Rubber, Gutta-Percha and Telegraph Works Company, died on Monday, December 16th. Mr. Gray was a member of the Society since 1876. He was born in 1821, at Lanark, N.B., and after serving an engineering apprenticeship in Glasgow, came to London in 1840 to study marine engineering. He subsequently visited the United States and Canada, and returned to this country to take the management of a large cotton factory in Glasgow. In 1863 he joined the late Mr. John Proudfoot in a concession from the Government of the Argentine Republic and the Banda Oriental, to lay a telegraph cable between Monte Video and Buenos Ayres, which was opened for traffic in 1866, and was the first submarine cable laid in South American waters. Since then he has been connected as the active head of the great Silvertown firm with the manufacture and laying of a very large number of submarine cables in all parts of the world.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 15.—"Elliptographs." By FRANK J. GRAY, Assoc.M.Inst.C.E., F.R.Met.S.

JANUARY 22.—"Scientific Observations at High Altitudes." By REV. J. M. BACON.

JANUARY 29.—"Technical Education as Applied to Paper Making." By CLAYTON BEADLE.

FEBRUARY 5.—"Jamaica." By HERBERT T. THOMAS.

FEBRUARY 12.—"Industrial Redistribution." By WILLIAM LEONARD MADGEN.

FEBRUARY 19.—"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A. GENERAL SIR GEORGE WENTWORTH A. HIGGINSON, K.C.B., will preside.

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 23.—"Bengal: the Land and its People." By FRANCIS HENRY SKRINE, late H.M. Indian Civil Service. The Right Hon. SIR RICHARD TEMPLE, Bart., G.C.S.I.. C.I.E., will preside.

FEBRUARY 6.—"The Coal Resources of India." By PROFESSOR WYNDHAM R. DUNSTAN, F.R.S. The Right Hon. LORD GEORGE HAMILTON, M.P., will preside.

FEBRUARY 27.—"The Industrial Development of India." By NILKANTH B. WAGLÉ, B.A. The EARL of HARDWICKE will preside.

MARCH 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By THOMAS WILLIAM HOLDERNESS, C.S.I., Secretary, Revenue Department, India Office.

APRIL 17.—"Our Commercial Relations with Afghanistán." By COLONEL SIR THOMAS HUNGERFORD HOLDICH, R.E., K.C.I.E., C.B.

MAY 1.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 28.—"To the Victoria Nyanza by the Uganda Railway." By COMMANDER B. WHITEHOUSE, R.N.

FEBRUARY 18.—"The French Canadian Relationship to the Crown." By W. T. R. PRESTON, Chief Inspector Canadian Government Emigration Agencies.

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G.

APRIL 22.—"British Commercial Prospects in the Far East." By BYRON BRENAN, C.M.G., late H.M. Consul-General at Shanghai.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

JANUARY 21. 8 p.m.—"The Architect's Use of Enamelled Tiles." By HALSEY RICARDO. PAUL WATERHOUSE, M.A., will preside.

FEBRUARY 4. 4.30 p.m.—"The History of the Rosary in all Countries." By the REV. HERBERT THURSTON, S.J. His Eminence CARDINAL VAUGHAN will preside.

MARCH 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY. WALTER CRANE, A.R.W.S., will preside.

APRIL 8. 8 p.m.—"Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington. H. H. STATHAM, F.R.I.B.A. will preside.

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

SAMUEL RIDEAL, D.Sc., F.I.C., "The Purification and Sterilisation of Water."

January 13, 20, 27, February 3.

LECTURE I.—JANUARY 13.—*Purification by Uncontrolled Natural Agencies.*—Conditions of purity—Influence of physical and chemical properties on the fitness of a water for public supply—Natural distillation—Rain-water—Secondary purification in nature—Bacterial action—Percolation through soil—Sedimentation in surface water—Effect of agitation, air, light and animal and vegetable life—Turbid rivers—Protection of sources.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 6...Chemical Industry (London Section), Burlington-house, W., 8 p.m. Prof. J. T. Hewitt, "The Retarding Influence of Aldehydes on the Maturation of Spirits."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. John Hanson, "Rivers' Pollution: Purification of Trade Waters from a Mill Occupier's Point of View."

British Architects, 9, Conduit-street, W., 8 p.m. Dr. A. S. Murray, "Two Ionic Capitals at the British Museum."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Rev. Chancellor J. J. Lias, "Modifications in the Idea of God."

TUESDAY, JAN. 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. J. A. Fleming, "Waves and Ripples in Water, Air, and Æther." (Lecture V.)

Pathological, 20, Hanover-square, W., 8½ p.m.

WEDNESDAY, JAN. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Sir Henry Trueman Wood, "Photography and its Applications."

Geological, Burlington-house, W., 8 p.m.

Royal Literary Fund, 7, Adelphi-ter., W.C., 3 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. (Juvenile Lecture.) Dr. Maguire, "The British Army in South Africa."

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m. Annual Meeting.

THURSDAY, JAN. 9...Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. J. A. Fleming, "Waves and Ripples." (Lecture VI.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion of the Technical Reports on the Institution Visit to Germany, 1901.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 10...Astronomical, Burlington-house, 8 p.m.

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

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FRIDAY, JANUARY 10, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, January 13, 8 p.m. (Cantor Lectures).—Samuel Rideal, D.Sc., "The Sterilisation of Water." (Lecture I.)

Wednesday, January 15, 8 p.m. (Ordinary Meeting).—Frank J. Gray, A.M.Inst.C.E., "Elliptographs."

Further details of the Society's meetings will be found at the end of this number.

JUVENILE LECTURES.

The second and last lecture of the course of Juvenile Lectures on "Photography and its Applications" was delivered on Wednesday, 8th inst., by Sir Henry Trueman Wood.

At the commencement of the lecture an enlargement on silver bromide paper was developed, and this afforded an opportunity for an explanation of the way in which the photographic image was retained and fixed upon a suitable surface. The manner in which the colour of the silver image could be altered by treating it with various metallic solutions was demonstrated by the exhibition of a number of slides of various tones. Certainly many, probably most, and possibly all, substances were affected by the action of light, but only a few were available for photographic purposes.

Amongst these the most important were the sensitive salts of silver, salts formed by the combination of silver with such a material as bromine. Other metallic salts were also available and were employed. Amongst them were the salts of iron, the sensitiveness of which was the foundation of the beautiful platinotype process, perhaps the best of all methods for obtaining a photographic picture. Gelatine and other similar materials, combined with such a salt as potassium bichromate, were sensitive to light, the parts acted upon by light being hardened and rendered insoluble, while the unaffected portions could be dissolved away by hot water. This was the foundation of the well-known carbon or autotype process.

This part of the lecture was illustrated by pictures lent by the Autotype Company, the Platinotype Company, Kodak, Ltd., and Messrs. Morgan and Kidd, also by a collection of examples showing photographic action on various materials, leather, coloured papers, &c.

Bitumen was another sensitive material, by the use of which the first of all photographic pictures had been produced, and it still played a useful part in the production of typographic printing surfaces. This led up to a discussion of the various methods of producing by photographic means surfaces which could be used for printing in the press; and the lecturer showed how, by the use of a suitable lined screen, the different shades of a photographic picture could be broken up and translated into lines and dots, suited for the reception of printer's ink, and capable of being used in the press in the same way as ordinary printing type.

The next subject was the production of colour by photographic methods. The only direct process for this purpose—the very beautiful device of Professor Lippmann—had hardly passed as yet beyond the experimental stage, and consequently we were driven to use indirect methods—methods which involved the use of colouring materials or dyes. The principles of the "Three-colour process" were then explained, and it was shown how coloured transparencies could be produced, firstly by combining on the screen the images from three monochrome positives, each illuminated by light of its proper colour, and secondly by the transmission of light through three superimposed prints, each stained its proper colour.

This portion of the lecture was illustrated by experiments with the spectrum and with a triple lantern, as well as by the exhibition of a collection of lantern slides by Mr. Sanger Shepherd and others.

The application of similar methods to printing in colour was then referred to, and illustrated by a very fine collection of examples lent by Messrs. Bemrose and Sons, the proprietors of *The Graphic*, the proprietors of *The Sphere*, and Mr. Carl Hentschel.

An example of an entirely new method of producing the stereoscopic effect in a single picture, and without the use of a stereoscope, the invention of Mr. Ives, was exhibited. Though it had been shown in America, it had not before been seen in this country.

A demonstration of Mr Robert W. Paul's animatograph concluded the lecture.

On the proposition of the Chairman (Sir William Preece, K.C.B., F.R.S.) a vote of thanks was passed to the lecturer.

The lecturer has again to acknowledge his indebtedness to many who have helped him by the loan of pictures, apparatus, &c., for the second lecture. His best thanks are due to the following: Sir William de W. Abney, Miss Acland, Mr. T. Bolas, Mr. J. D. Geddes, Mr. Andrew Pringle, Dr. Otto Ruff, Mr. Carmichael Thomas, Dr. Leon Williams, the Council of the Royal Photographic Society, the Proprietors of *The Graphic*, the Proprietors of *The Sphere*, The Autotype Co., Messrs. Bemrose and Sons, The Biograph Co., Messrs. Cross and Bevan, Messrs. Carl Hentschel, Ltd., Messrs. W. C. Horne and Sons, Kodak, Ltd., Messrs. Morgan and Kidd, Mr. Robert W. Paul, Messrs. A. W. Penrose and Co., the Platinotype Co., Messrs. E. Sanger Shepherd and Co., and Messrs. Walker and Cockerell.

During the lecture a lantern slide of Mr. Hodsell's photograph of the audience at the first lecture was shown. The picture itself will appear in the *Sphere* of the 25th inst.

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CANTOR LECTURES.

THE CHEMISTRY OF CONFECTIONERS' MATERIALS AND PROCESSES.

By William Jago, F.C.S., F.I.C.

Lecture III.—Delivered December 9th, 1901.

Incidental mention was made at the close of our last lecture of sugar as the sweetening agent of flour confectionery; and it was also stated that it formed the basis of those goods known as confections proper, and which must engage our attention under the heading of sugar confectionery. Many of these goods are little else than chemically pure sugar, worked up into novel and attractive shapes by the art of the confectioner. In many others sugar is still almost the whole of the substance, other bodies being present only in comparatively small quantities of flavouring matters. In another group, sugar forms the matrix or magma, with which nuts or other bodies may be incorporated, but even in these sugar is the dominating ingredient.

Composition and Properties of Sugar.

The term sugar was at one time used almost synonymously with sweetness, and accordingly all substances characterised by a sweet taste were termed sugars. Thus, acetate of lead, a powerful poison, was, and even is to some extent, known as "sugar of lead," simply because it possessed a sweet taste. Similarly saccharin, which is a coal-tar product, and not in the least allied to sugar proper, has not merely a sweet taste, but one some 250 times as sweet as that of sugar itself. It will be seen, therefore, that sweetness is not at all necessarily a property confined to true sugar, but rather one also possessed by other bodies of widely different chemical characters. Excluding substances of the kind referred to, we still find a group of bodies characterised by marked sweetness, and further closely allied to each other in chemical composition.

Among bodies which are naturally sweet, perhaps that best known is honey. Since this substance is collected and stored by bees, man, in even a most primitive state, was familiar with honey, and valued it because of its sweetness. It would seem that honey was once the staple sweetening agent of many peoples, being used for that purpose in this country, and also as a source of those beverages which require a sugar as their basis. Although collected by the bee, honey is naturally a vegetable product, and is obtained from flowers. Honey not only possesses sweetness, but also distinct and various flavours, due to certain odoriferous and flavouring matters present in the flowers from which it is derived. This most delightful and natural form of sugar is still used by the confectioner, and is one of the principal ingredients in the sweet basis of nougat, specimens of which are before you.

Cane sugar is probably the next earliest known of the sugars, being mentioned in the works of several writers B.C., and referred to by Pliny as "honey collected from canes like a gum, white and brittle between the teeth; the largest is the size of a hazel nut; it is used in medicine only." In common with many other vegetable juices, that of the sugarcane is sweet, and sugar in the pure and crystallised form is obtained therefrom by appropriate manufacturing operations. Cane sugar is that form by far most largely employed for confectioner's purposes, but there are other varieties also found in the vegetable kingdom which are serviceable in many ways. The animal kingdom is likewise laid under tribute by the confectioner for sugar, although in an indirect way. Milk contains the special variety of sugar known as sugar of milk or lactose, and when milk, either in its natural or its concentrated form, is employed in confectionery, milk sugar is one of the substances thus introduced.

A very few words must be said as to the chemical composition of the sugars. There is a well-known group of vegetable bodies to which the name of "carbohydrates" is given, because these bodies contain carbon and also hydrogen and oxygen, the latter in the same proportions as they exist in water. Among these bodies we have the following:—

Ordinary name.	Chemical name.	Formula.
Starch	Starch	$nC_6H_{10}O_5$
British gum	Dextrin	$nC_6H_{10}O_5$
Grape sugar	Glucose, dextrose	$C_6H_{12}O_6$
Fruit sugar	Lævulose	$C_6H_{12}O_6$
Cane sugar	Sucrose	$C_{12}H_{22}O_{11}$
Malt sugar	Maltose	$C_{12}H_{22}O_{11}$

In that most fascinating subject of scientific study, the constructive metabolism of plants, the wonderful problem of how the plant builds up its structure from the inorganic elements supplied by the soil and the atmosphere is investigated. The first step is probably the formation of some simple compound of carbon, hydrogen, and oxygen, such as possibly formic aldehyde CH_2O (the simplest possible carbohydrate). From this may be built up the more complex carbohydrates, as for example, cane sugar which may be viewed as twelve such simplest molecules with a molecule of water abstracted. Brown and Morris believe that the plant first forms cane sugar as an upgrade product, and that this is by the action of chlorophyll within the leaf converted into starch. This starch has to be conveyed from one part of the plant to another; and hence, by means of an agent called diastase, is decomposed into maltose and dextrin. At the same time any cane sugar remaining in the leaf is converted into dextrose and lævulose. We therefore have first, cane sugar as one of the steps in the up-grade of plant construction, then starch as the highest point, and next the down-grade sugars, dextrose and lævulose from cane sugar, and maltose from starch respectively. It will be seen, then, that the group of bodies cited in the preceding Table are all of them closely allied, and in the living plant are easily converted from one into another.

The earlier names given to the sugars were derived from the source of each particular sugar; but it is now well known that one and the same variety of sugar may be obtained from a number of sources. When, therefore, a sugar is named cane sugar, the name indicates not necessarily that the sugar in question is derived from the sugar-cane, but that it is sugar of precisely the same kind as that originally derived from that source. Cane sugar occurs not only in the juice of the sugar-cane, but also in certain roots, especially that of the beet, and in the sap of some trees, of which maple sugar is a familiar example. Various seeds, such as the almond, barley, and fruits also contain cane sugar. The process of manufacture consists first in expressing the juice whether of the cane or the beet, heating to boiling point, and then getting rid of various impurities by the addition of lime. To get rid of the colour the solution of sugar is filtered through animal charcoal, after which the syrup is evaporated in steam-heated pans and finally *in vacuo*. Crops of crystals of sugar are thus obtained, leaving behind a residuum of syrup known as molasses. The whole juice of the sugar-cane when concentrated forms a pleasant smelling and tasting syrup; therefore the molasses from cane sugar is pleasant to the taste. The concentrated beet juice contains, however, substances which are not pleasant in odour or taste, and, therefore, beet sugar molasses is not acceptable for food purposes. So long as sugars are imperfectly refined, and not absolutely freed from the residual syrup, beet sugar is inferior in quality to that of the cane. But by modern processes, the sugar is obtained in what is essentially a chemically pure state, and in this condition sucrose, whether derived from the cane or the beet, is identical in character, and samples obtained from the two sources are undistinguishable from each other.

Pure cane sugar is soluble in about half its weight of cold water, and in hot water in all proportions. On evaporation the sugar readily crystallises out in colourless transparent crystals. The solution is intensely sweet, and of a higher density than water; the proportion of sugar in such a syrup may be approximately determined from the specific gravity.

On heating cane sugar it melts at a temperature of 160°C. (320°F.), and if allowed to cool quickly forms an amorphous substance, which, prepared under careful conditions, is the basis of the sweetmeat known as barley sugar. In this form, cane sugar probably exists as a definite allotropic modification, bearing much the same relation to crystalline cane sugar as plastic sulphur does to the crystalline forms of that element. Also, like the sulphur, the tendency to crystallise causes the sugar to gradually become opaque owing to its once more assuming the crystalline condition.

If the temperature be maintained for some time just a little above the melting point, the sugar is changed without loss of weight into a mixture of dextrose, and a substance called lævulosan, thus :—

$$\underset{\text{Sucrose.}}{C_{12}H_{22}O_{11}} = \underset{\text{Dextrose.}}{C_6H_{12}O_6} + \underset{\text{Lævulosan.}}{C_6H_{10}O_5}.$$

Further application of heat causes water to be given off, with the probable conversion of the dextrose into glucosan, thus :—

$$\underset{\text{Dextrose.}}{C_6H_{12}O_6} = \underset{\text{Glucosan.}}{C_6H_{10}O_5} + \underset{\text{Water.}}{H_2O}.$$

At a yet higher temperature further decomposition ensues, both lævulosan and glucosan being converted into caramelan, $C_{12}H_{18}O_9$, thus :—

$$\underset{\substack{\text{Glucosan}\\ \text{and lævulosan.}}}{2C_6H_{10}O_5} = \underset{\text{Caramelan.}}{C_{12}H_{18}O_9} + \underset{\text{Water}}{H_2O}.$$

Caramelan when pure is colourless, has a slightly bitter taste, and is highly deliquescent.

Further elevation of temperature to from 374° F. (190° C.) to 410° F. (210° C.) results in the formation of so-called caramel, which is a mixture of dark-brown bodies, more or less soluble in water and alcohol.

Optical Saccharimetry.—White and refined sugars are usually almost chemically pure, but with the raw or moist sugars there are present more or less water, and sugars of the glucose type. Modern methods of sugar assay depend almost entirely on certain optical properties possessed by sugars and other substances. Without going very deeply into the subject, in an ordinary ray of light, the ether particles vibrate in a plane at right-angles to the ray, and in every direction in that plane. By passing through certain substances the character of that light is so altered that the vibrations are in one direction only; such a ray of light is said to be "polarised." For purposes of illustration only, the ordinary ray of light may be compared to the round pencil of light that would escape through a round hole in an otherwise dark lantern. The polarised ray may be compared to a slice-like ray such as would pass through a long narrow slit. One may be likened to a round rod of steel and the other to a flat ribbon of the same metal. Just as one may take such a steel ribbon and holding the one end stationary, twist the other to the right or left, so there are some substances which exercise the same kind of twisting or rotatory power on the ray of polarised light. Among these are the sugars, some of which give the ray a right-handed twist, as cane sugar, and others give it a left-handed twist, as does lævulose. Further, the amount of twist is constant for the same substance under the same conditions. The polarimeter is an instrument consisting first of a prism called the polariser, by which the ray of light is polarised. There is then a space into which the subject under examination can be placed, and then another prism called the analyser, which exhibits a well-marked appearance when in the path of the polarised ray. This latter can be caused to revolve, the number of degrees through which it passes being indicated by a scale. With nothing between the polariser and analyser, or a tube full of water or other inactive substance, the ray of polarised light is not rotated, and both polariser and analyser are at the same angle. But if a solution of cane sugar, for example, is placed in a tube between the two, then rotation occurs. The analyser is then turned round until seen, by the recurrence of the marked appearance before referred to, to be once more in the path of the twisted polarised ray. The direction and number of degrees through which it has been turned are then read off from the scale and noted. From this measure of the amount of angular rotation the amount of sugar can be determined. Thus, if a solution be prepared containing one gram of cane sugar in 100 cubic centimetres, and a tube 2 decimetres in length is filled with this solution and placed in the polarimeter, then the ray of polarised light will be twisted to the right through 1·35 angular degrees. Conversely, if 1 gram of a sugar of unknown strength were thus dissolved in water and read by the polarimeter, a solution of 1·35° would indicate the presence of 1 gram of sugar per 100 c.c. (assuming no other optically active substance is present except cane sugar); and as 1 gram of the sugar was dissolved up, the particular sample would have a strength of 100 per cent., or, in other words, is pure sugar. Such is the principle of the use of the polarimeter : for instructions as to its use in valuation of sugars, the larger works on analysis must be consulted.

Inversion of Cane Sugar.—When a solution of cane sugar is heated with dilute acid, a change occurs similar to that taking place in plants when sucrose is converted into dextrose and lævulose. With the addition of 5 per cent. of concentrated hydrochloric acid solution this change is complete in about ten minutes at a temperature of 68° C. Weaker solutions of acid require a longer time and a higher temperature, but in any case exposure to acid at a high temperature changes more or less of the sugar. The chemical change is expressed in the following equation :—

$$\underset{\text{Sucrose.}}{C_{12}H_{22}O_{11}} + \underset{\text{Water.}}{H_2O} = \underset{\text{Dextrose.}}{C_6H_{12}O_6} + \underset{\text{Lævulose.}}{C_6H_{12}O_6}.$$

The one molecule of sucrose has combined with one molecule of water to produce one molecule each of dextrose and lævulose. These latter two molecules are often spoken of collectively as "glucose." As this change consists of the assimilation of water by the cane sugar it is defined as one of hydrolysis. Dextrose rotates polarised light to the right, but in a slightly less degree than cane sugar; lævulose twists polarised light about half as far again to the left as cane sugar does to the right. The consequence of this is that the mixture of dextrose and lævulose has a left-handed solution, and such mixture is frequently spoken of as *invert* sugar and the act of so changing sucrose as the *inversion* of cane sugar. Dextrose is found largely in the juice of grapes. When dried into raisins, these on becoming old develop gritty masses in their interior. These little lumps are aggregates of small crystals of dextrose, which at times is called grape sugar. The lævulose, so-called from its left-handed rotation, is at times spoken of as fruit sugar, and crystallises only with great difficulty; hence its presence acts as a preventative of crystallisation. If a saturated cold solution of cane sugar be divided into two equal parts, and the one inverted by treatment with hydrochloric acid, the two may be placed away together for purposes of observation. Even though the unaltered sucrose have water added to it in the same volume as hydrochloric acid was added to the other, yet as time proceeds the cane sugar crystallises rapidly. In such solutions thus made and set aside by the lecturer, the cane sugar had at the end of some three weeks become almost solid, while not a single crystal had developed in the solution of invert sugar. Not only is invert sugar itself singularly free from a tendency to crystallise, but its presence tends also to prevent crystallisation of cane sugar present in the same solution. Striking illustrations of this occur in the boiling of jams, where a solution of sugar is heated with fruit containing organic acids. In a sample of raspberry jam made in the lecturer's laboratory from cane sugar and fruit only, he found, after keeping, that some 50 per cent. of the sugar had undergone inversion. In sugar boiling, as already mentioned, cane sugar is changed into an amorphous variety, and hence the "glassy" type of sugar in such sweets as barley sugar. Still in these there is the tendency to crystallise, and such sweets would become opaque on being kept. To prevent this, acid is added during the boiling, and by the inversion of part at least of the sugar completely prevents, or very considerably retards, the process of crystallisation. Whenever sugar is inverted by acid during a process of sugar working, or invert sugar is introduced in a mixture, than the general effect is to retard or prevent crystallisation. Although invert sugar or glucose is thus almost continually being formed from many sugar-working processes, yet it is rarely if ever added or employed as a previously prepared product by the confectioner.

Starch-sugar, Maltose. — Just as cane sugar is changed by acids and other bodies into glucoses, so starch is somewhat similarly converted into sugar and an allied body. One of the most familiar instances of this change is that which occurs during the mashing of malt as a preliminary operation in brewing. Malt itself contains about 50 per cent. of starch and from 9 to 16 per cent. of ready-formed sugars, of which about half is usually sucrose. Among the proteid matters of malt is the substance termed diastase, which has the very striking characteristic of being able to effect the hydrolysis of starch. The brewer grinds the malt and infuses it with water at a temperature ot about 140 to 150° F. The diastase then acts on the starch, effecting a change which in its simplest form is expressed in the following equation :—

$$\underset{\text{Starch.}}{5C_6H_{10}O_5} + \underset{\text{Water.}}{2H_2O} = \underset{\text{Dextrin.}}{C_6H_{10}O_5} + \underset{\text{Maltose.}}{2C_{12}H_{22}O_{11}}.$$

That is to say, of the starch about 20 per cent. is converted into dextrin and the remainder into malt sugar or maltose. The malt infusion thus obtained is filtered, and may be "hopped," and by fermentation converted into beer; or it may be evaporated *in vacuo*, in which case it leaves behind a syrupy liquid to which the name of malt extract is given, and samples of which are before you. Malt extract is of a light brown colour and possesses the agreeable and very characteristic flavour and aroma of malt. In addition to the dextrin and sugar it also contains the soluble proteid and mineral matters of the malt. On being kept, malt extract slowly passes from the liquid or amorphous state to a crystalline condition and presents the appearance of the sample before you. The crystalline portion consists probably of the cane sugar and also more or less of the maltose of the extract.

Starch is a less expensive body than malt, and hence forms a much cheaper source of malt- or starch-sugar. If starch be dissolved in water by the action of heat and then treated with acid a change occurs which is very similar to that expressed in the foregoing equation. But while diastase is incapable of carrying hydrolysis further than maltose, acids produce by further conversion more or less glucose. Starch-sugar finds many uses and consequently its production is an important branch of manufacture. Maize starch is that most commonly employed and is well-known to the public under the name of corn-flour. Starch, water, and a small quantity of sulphuric acid are heated together in large wooden vats by the introduction of steam. This operation is continued until a small portion of the liquid ceases to give the starch reaction with iodine. Chalk (calcium carbonate) is next added in slight excess, so as to neutralise the acid. The calcium sulphate is allowed to settle, and the upper liquid decolourised by filtration through animal charcoal, and concentrated by evaporation until the solution, when cold, has a specific gravity of about 1·3 to 1·4. Starch-sugar thus obtained is a colourless, odourless, and transparent syrup, possessing a pleasant, sweet taste, as may be judged from the sample shown you. The following are analyses of malt extracts and commercial starch-sugars :—

Constituents.	Malt extract. No. I.	Malt extract. No. II.	Starch sugar. No. I.	Starch sugar. No. IIA.	Starch sugar. No. IIB.	Starch sugar. No. IIC.
Water	22·23	26·30	18·24	15·20	15·20	15·20
Mineral matter	1·10	1·60	0·26	0·18	0·18	0·18
Proteids	3·01	5·40	—	—	—	—
Dextrin	12·90	7·65	16·00	16·20	16·20	21·38
Sucrose	3·59	4·07	—	—	—	—
Maltose	54·84	47·01	55·50	59·00	60·92	48·98
Dextrose & Lævulose (glucose)	2·33	7·97	10·00	9·42	7·50	14·26
	100·00	100·00	100·00	100·00	100·00	100·00

From these analyses it will be seen that the solid matters of malt extract consist principally of dextrin and maltose, in addition to which there is a fair proportion of sucrose and glucose, and also proteid and mineral matter. The starch-sugar, being made from the purified starch only, contains none of the ready-formed sugars of the grain, nor any proteids. The mineral matter consists of a trace of calcium sulphate held in solution in the syrup. The essential constituents of starch-sugar are dextrin and maltose, which in the figures given in the first analysis, together form about 87 per cent. of the total solid matters present. The remainder consists almost entirely of dextrose. Starch-sugar has a remarkably high right-handed rotary power on polarised light, the figure for the first sample quoted being 2·75° per gram of solids in 100 cubic centimetres of the solution when measured in a two-decimetre tube. Under similar conditions of measurement, the following are the rotary power of various compounds :

Pure dextrin right-handed or	+ 3·86°
,, maltose	+ 2·78°
,, cane sugar (sucrose)	+ 1·35°
,, dextrose (right-handed glucose)	+ 1·04°
,, lævulose (left-handed glucose)	— 1·96°
Invert sugar or glucose (equal quantities of dextrose and lævulose)	— 0·46°

It will be seen, therefore, that starch-sugar has about double the right-handed rotary power of cane sugar, which high figure absolutely differentiates it from invert sugar or glucose, with its left-handed rotary power. In the analysis quoted the high rotary power indicates that the proportion of glucose present (if any) must consist practically entirely of dextrose, or the right-handed variety of glucose.

In view of the fact that the composition of starch-sugar as stated by the lecturer differs materially from that commonly accepted, the following details of analysis are given, being those of sample No. II. :—

Density of 20 per cent. solution	1065·1
Rotary power of 20 per cent. solution in 200 millimetre tube	47·216°
Rotary power per gram of solids in 100 c.c., measured in 200 m.m. tube	2·78°
Specific rotary power of whole substance	118·04°
,, ,, organic solids of substance	139·0°
Cupric oxide reducing power of whole substance determined gravimetrically, calculating all reducing sugars as glucose (K)	per cent. 44·62
All reducing sugars as maltose	71·35

Water—		
From solution density	15·5	
By evaporation	14·9	
Mean		15·2
Solids—		
From solution density	84·5	
By evaporation	85·1	
Mean		84·8
Ash by ignition		0·18
Organic solids	84·8 − 0·18 =	84·62
Dextrin by direct precipitation with alcohol, 10 c.c. of 10 per cent. solution, added to 250 c.c. of 93 per cent. alcohol, precipitated, washed and weighed; quantity per cent.		16·20

As a check on the dextrin determination, a control experiment was made in which 0·2 gram of pure dextrin was precipitated in the same manner.

	Grams.
There was recovered as precipitate	0·1890
,, ,, ,, by evaporation of filtrate	0·0105
	0·1995

In making the determination on starch-sugar the correction for solubility was added.

In column No. IIA. of preceding Table, the maltose and dextrose are calculated from the opticity thus—

Taking the 20 per cent. solution, it contains, in grams, per 100 c.c.

Dextrin	3·24
Sugars	13·72
Organic solids	16·96

The rotation due to dextrin is

$$3{\cdot}24 \times 3{\cdot}86 = 12{\cdot}506^\circ$$

The rotation due to sugars is

$$47{\cdot}216 - 12{\cdot}506 = 34{\cdot}71^\circ.$$

If all the sugar present consist of maltose, then opticity, 13·72 × 2·78 =	38·08°
If all the sugar present consist of dextrose, then opticity, 13·72 × 1·04 =	14·24°
Difference	23·84°

The observed rotary power, 34·71°, lies between the two, and, therefore, the sugars are a mixture of maltose and dextrose, from which the respective percentages are calculated as follows :—

$$\frac{(34{\cdot}71 - 14{\cdot}24) \times 13{\cdot}72}{23{\cdot}84} = 11{\cdot}8 \text{ grams}$$

of maltose, per 100 c.c. of 20 per cent. solution. Then 13·7 — 11·8 = 1·9 of dextrose.

These numbers multiplied by 5 give the percentages quoted in the Table :

11·8 × 5 = 59·0 per cent. of maltose.
1·9 × 5 = 9·5 ,, ,, dextrose.

In column No. IIB. of the Table, the maltose and dextrose are calculated from the cupric oxide reducing power.

The difference between the percentage of organic solids and precipitated dextrin being regarded as sugars we thus have—

$$84{\cdot}62 - 16{\cdot}20 = 68{\cdot}42 \text{ per cent.}$$

As the reducing sugars calculated as maltose and as dextrose amount to 71·35 and 44·62 per cent. respectively, the figure 68·42 lies between these, and the sugars must consist of a mixture of maltose and dextrose. From these figures the percentages of each may be calculated—

$$\frac{(68{\cdot}42 - 44{\cdot}62) \times 68{\cdot}42}{71{\cdot}35 - 44{\cdot}62} = 60{\cdot}92 \text{ per cent.}$$

of maltose, and 68·42 — 60·92 = 7·5 per cent. of dextrose, which are the figures given in the Table.

It will be observed that the percentages of maltose and dextrose, calculated from opticity, agree substantially with those calculated from cupric reducing power.

On page 365, vol. I., of the third edition of "Allen's Commercial Organic Analysis," the author suggests a method of calculating percentages of dextrin, maltose, and dextrose from the organic solids, specific rotary power, and cupric reducing power. In column No. IIC., the composition of the sample is calculated from this formula and the data already given. It will be observed that the dextrin and dextrose are much higher than when the dextrin is directly determined and the other constituents calculated from either the opticity or cupric reducing power.

From particulars before given, it will be seen that determination by precipitation accounts for practically the whole of the dextrin. It was thought well, however, to investigate the nature of this precipitate rather more closely. On being re-dissolved, it was found to give a considerable amount of precipitate with Fehling's solution. A larger quantity was therefore prepared in the following manner. From 50 to 60 grams of the starch-sugar No. II. was dissolved in about 100 c.c. of water, and added to about 1,250 c.c. of re-distilled methylated spirits of 93 per cent. strength by the hydrometer. The dextrin came down as a flocculent precipitate, was thoroughly shaken up, and then the liquid was heated to boiling point and allowed to coo slowly. The dextrin then adhered to the walls of the flask. The spirit was poured off, the dextrin dissolved in about 100 c.c. of water, filtered and again precipitated by exactly similar treatment with alcohol. The operation was repeated a third time, the spirit last used being of 89 per cent. hydrometer strength. On dissolving up the precipitated dextrin, evaporating, drying and weighing, a quantity of about 8 grams was recovered. A 10 per cent. solution of this dextrin had a rotary power of 18·15° in the 100 m.m. tube, equal to a specific rotary power of 181·5°, a figure which is considerably below that given for pure dextrin.

A gravimetric determination of cupric reducing power gave, on calculating

Reducing sugars, as glucose (K) .... 13·51

and

Reducing sugars, as maltose .... 23·84

Assuming the precipitated "dextrin" to consist of dextrin and maltose, we thus have

Dextrin	76·16
Maltose	23·84

as the composition of this body.

On calculating the specific rotary power from the composition as above, we have

$$\frac{76{\cdot}16 \times 198}{100} = 150{\cdot}79$$

$$\frac{23{\cdot}84 \times 139{\cdot}2}{100} = \underline{33{\cdot}18}$$

$$183{\cdot}97$$

a figure which closely agrees with the observed opticity. It would appear, therefore, that dextrin precipitated in this manner, contains nearly a quarter of its weight of maltose. It is scarcely probable that any notable proportion of *free* maltose could thus be several times precipitated with dextrin. As malto-dextrin is not separable into maltose and dextrin by any possible treatment with alcohol, but is dissolved and precipitated as a homogeneous substance, the obvious deduction is that starch-sugars contain malto dextrin in considerable quantity. As the molecular weight of malto-dextrin,

$$\left\{\begin{array}{l}C_{12}H_{22}O_{11}\\(C_{12}H_{20}O_{10})_2,\end{array}\right.$$

is 990 against 342 for maltose, then 23·84 per cent. of maltose is equivalent to 69·01 per cent. of malto-dextrin, and the composition of the precipitated matter becomes

Dextrin	30·99
Malto dextrin	69·01
	100·00

Modifying the figures given in column No. IIa., in the light of this investigation of the matter precipitated by alcohol, we have the following approximate composition of the sample of starch-sugar :—

Water			15·20
Mineral matter			0·18
Dextrin			5·02
Malto-dextrin	Dextrin	7·32	11·18
	Maltose	3·86	
Maltose			68·42
Dextrose			nil.
			100 00

That is to say, the dextrin being

5·02 + 7·32 = 12·34

instead of 16·20, we have in the 20 per cent. solution 2·47 grams of dextrin and 14·49 of sugars, making 16·96 grams of organic solids per 100 c.c. instead of 13·72 grams of sugars as assumed in the previous calculation. Then if

14·49 × 2·78 = 40·28°,

the observed rotation is greater than that required for the whole of the sugar being maltose, and precludes the presence of any dextrose. The total maltose, 3·86 + 68·42 72·28, in the modified analysis, agrees closely with the figure obtained when the reducing sugars are calculated entirely as maltose, viz., 71·35 per cent. If the conclusion based on the analysis of this sample be correct, the substance known as starch-sugar may be viewed as essentially a mixture of dextrin, malto-dextrin, and maltose.

With the well-marked composition of starch-sugar it is to be regretted that the name used both popularly and commercially is a misnomer. Starch-sugar is commonly called starch "glucose," whereas evidently a far better name is either starch-sugar or, if preferred, "starch-maltose."

It is common knowledge that recently the invert sugar produced by one British manufacturer was found to be contaminated with arsenic. As a result an active search for that poison has been made in all sorts of articles of food, and among these starch-sugar, because of its unfortunate popular name, has been an object of much suspicion. Many samples of such starch-maltose have been examined by the lecturer for arsenic, and up to the present he has not found one containing any arsenic contamination ; neither, so far as he is aware, has any specimen of this substance, among the multitude which have been submitted to analysis by public analysts and others, received condemnation. It is no more than justice to state that starch-sugar or starch-maltose is made from pure materials, absolutely harmless in the manner in which they are employed, and that the manufacture is conducted under perfectly sanitary conditions. In fact, neither on scientific, nor even on sentimental grounds, is there anything any more objectionable in the manufacture of starch-maltose than there is in that of cane sugar.

Of the constituents of starch-sugar it may be said that maltose, although a crystalline sugar, crystallises much less readily than does cane sugar. Dextrin, or as it is sometimes called, British gum, is a tasteless gummy body, which does not crystallise itself, and exercises an inhibitory action on the crystallisation of other sugars. Its use is, therefore, as a preventative of crystallisation; and in some goods starch-sugar is employed, in order to prevent cane sugar crystallising, on much the same lines as a portion of the cane sugar is inverted by the addition of cream of tartar or other similar acid during sugar boiling. In addition to this, dextrin also seems to exercise a specific moisture-retaining effect, and the use of starch-sugar is therefore indicated in those goods which are desired to retain a moist character.

In conjunction with malt extract, one may mention a confection in the strict or older sense of the term. The original confections were made by the man who united in himself both the functions of the druggist as well as the chemist; and his object was to cover and render tolerable nauseous drugs by compounding them into a sugar confection. This original aim of confectionery is now more honoured in the breach than the observance, but still we have the strict confection of malt extract and cod liver oil. This compound is prepared by gently warming together about three parts of malt extract and one of cod liver oil, when a homogenous product is the result. That this is a true solution of the oil in the malt extract, rather than a mixture or emulsion, is shown by microscopic examination, for no signs of the separate ingredients are perceptible. If, however, a drop of water be allowed to enter under the side of the cover glass, solution of the extract in the water is observable, while at the same time drops of oil are seen to separate. Although a confection, this mixture is scarcely a sweetmeat; but the same principle of solution of fat in sugar is the basis of some of the most delectable of all sweetmeats. For cod liver oil substitute the best butter, and for malt extract cane sugar, partly inverted by cream of tartar, or a mixture of cane sugar and starch-maltose; heat together, and the fat again dissolves in the sugar, and is retained by it in cooling with the production of butter-scotch, Everton toffee, or other similar articles of confectionery, according to details of manipulation or flavouring ingredients.

With this introduction let us try to follow the ingredients and chemical changes described in their application to the actual production of confectionery.

Pure Sugar.—In days when sugar was rarer and more expensive, the actual raw sugar itself was thought a delicacy and eaten as a sweetmeat. An interesting record of this is that given in Kingsley's historical novel, "Westward Ho," in which before the Armada, Admiral John Hawkins remembers Great Granfer Martin Cockrem, and from out his pocket

> "Struggle a piece of tarred string, a bundle of papers, a thimble, a piece of pudding-tobacco, and last of all, a little paper of Muscavado sugar—then as great a delicacy as any French bonbons would be now—which he thrusts into the old man's eager and trembling hand."

Sugar Candy.—Even at present, although probably to a less extent than a generation or two ago, pure sugar *au naturel* is sold as a sweetmeat under the name of sugar-candy. This body is simply crystallised sugar, the brown form being produced by crystallising a saturated solution of brown sugar, while the white candy is prepared from a colourless syrup. If to this latter, colouring matter be added, the resultant candy is also coloured. In manufacture, the sugar solution is boiled to a state of saturation or super-saturation, and then poured into vessels, across which are stretched pieces of string. The liquid being kept warm, evaporation slowly proceeds, and the sugar is deposited in large irregular crystals on the sides of the vessels and on the strings. In the case of a colourless solution, crystals of almost chemical purity are thus obtained.

Lozenges are prepared by making very finely ground white sugar into a paste or dough by means of a solution of gum. Flavouring and colouring ingredients may also be incorporated, after which the lozenges are cut out of rolled sheets of the paste by appropriate machinery, and then dried at a gentle heat.

Sugar Boiling.—The history already given of the chemical changes occurring when sugar is subjected to the action of heat will serve as a prelude to a description of what is called sugar boiling by the confectioner. At this stage the lecturer proposes just to describe in very brief outline, this process as it appears to the practical boiler, and then to endeavour to trace the connection existing between his experience and the more purely scientific investigations of the same subject. Sugar boiling is usually conducted in deep round copper pans, the size of which will naturally depend on the extent of the contemplated operations. These pans may be heated either by gas or direct fire heat. It is well to have an ample margin of sufficiency of heat, since rapid heating to a given point will produce results which differ from slowly raising the temperature to the same degree. Let us follow a small batch through the whole history of sugar boiling. The confectioner places in his pan say 7 lbs. of white cube sugar or crystallised sugar, and one quart of water. This is set on the fire and the contents raised to the boiling point: directly this occurs, the liquid is carefully stirred with a spatula, so as to dissolve any lumps of sugar which may happen to remain. At this stage we have a solution of sugar in very hot water. On continuing the boiling a little longer, the temperature of the solution rises, and if taken by a thermometer, will be found to be at from 215 to 220° F. Each particular stage of temperature corresponds to a certain degree of sugar boiling, to which a technical name is given. Thus at the temperature of 215 to 220°, the degree of *smooth* is reached. The workman identifies these degrees by physical tests which he applies to the sugar. Thus he dips a clay-pipe stem into the liquid, and draws it between the finger and thumb; at the *smooth* degree the sugar feels oily, and hence the name of the degree. Proceeding still further with the heating, a temperature of 230 to 235° is reached, and now the sugar is at the *thread* degree. During this time water has been driven off from the sugar, and now on cooling, the solution is sufficiently viscous to draw into *threads*, if a little is pulled out between the finger and thumb. With further heating, a temperature of 240 to 245° is reached, and the sugar is in the *blow* or *feather* degree. At this stage the liquid has become so viscous that the steam generated in boiling *blows* the mass into huge bubbles, and in fact, may easily boil over the pan. If a little of the sugar be tossed in the air, it will exhibit a *feathered* appearance. At 250 to 255°, we reach the *ball* or *pearl* degree, and a little of the sugar taken on a pipe stem or glass rod and dipped into water acquires a consistency about equal to that of putty. We now proceed to carry our heating operation a considerable distance further, and when the thermometer registers from 310° to 316°, the sugar is at the *crack* degree. If now cooled in water, the sugar rapidly hardens and becomes *brittle*. Very little further heating causes an incipient caramelising, and the confectioner's *caramel* degree is reached.

During these stages the water originally added is being driven off; while toward the last the sugar is undergoing those successive steps of degradation towards caramelan, by "shedding" or losing molecule after molecule of water. It will be noticed that throughout, the sugar still retains the chemical composition of a carbo-hydrate.

Cutting the Grain.—At this stage an explanation must be given of what the confectioner terms "cutting the grain" of sugar. When heated above 250° F. the sugar will, if allowed to cool, crystallise into a hard granular mass. The sugar, in fact, re-solidifies from fusion and crystallises in so doing. To "cut" or destroy this graining tendency, the confectioner employs some acid substance, that most frequently used being cream of tartar, which, as already mentioned in these lectures, consists of the acid tartrate of potash (hydrogen potassium tartrate). Instead of this, tartaric, citric. or acetic acids may be employed. The cutting agent may be added to the sugar when first mixed with water, and the whole heated together. Sugar thus treated, instead of graining, remains pliable while hot, and transparent when cold. The sugar has in fact lost its crystalline nature, and has become an amorphous or vitreous substance. From what has been previously explained, it will at once be seen that cutting the grain consists of inverting more or less of the sugar by means of an acid body.

Fondants.—It will be impossible to do more than trace out a very few types of the goods which by judicious modifications and combinations form the myriad manufactures of the confectioner. The confections known as fondants may be taken as an example. Sugar, water, and cream of tartar are boiled to the feather degree, and then in hand working the syrup is stirred until it becomes creamy through the production of minute crystals. On the large scale the same effect is obtained by pouring the requisitely boiled syrup into a vessel in which, during cooling, it is violently agitated by paddles or stirrers, crystallisation goes on, and the creamy mass of pure crystals, suspended in syrup, pours out from the lower end of the vessel. This liquid is next cast into moulds made in powdered starch, or on sheets of indiarubber, and thus fondants are manufactured. The crystalline portion of the fondant is simply unaltered cane sugar crystals, the softer and non-crystalline portion consists of invert sugar.

Boiled Sugar Goods.—A very well known and simple example of these, to which reference has already been made, is that termed barley sugar. Sugar is first boiled to the feather degree, then "cut" by the addition of cream of tartar, boiled to the "crack" degree, and flavoured with essence of lemon. The mixture is poured out on to a slab, and cut into strips, which are twisted and allowed to cool.

Acid Drops are sugar boiled to a similar degree, and flavoured with tartaric acid.

Bulls Eyes are flavoured with oil of peppermint.

Butter Scotch should receive special mention as a sweetmeat in which butter is incorporated with the sugar. The quantity of butter is usually about two ounces to the pound of sugar. That in toffee is or should be somewhat more.

Nougat is a confection interesting because of the presence of honey as a sugar basis. Honey and orange flower water are boiled together, then whites of eggs, castor sugar, and finely chopped almonds are incorporated. This may be considered as the basis of nougat, which is susceptible of almost indefinite modification.

Almond Paste is used both in flour confectionery and as a confection alone. Such paste consists of ground almonds, white sugar, and whites of eggs.

Chocolate now forms a most important branch of confectionery manufacture. The seeds of cocoa fruit are roasted, ground, and subsequently mixed with sugar, starch, and flavouring ingredients. This material, cut into blocks, constitutes plain chocolate, while chocolate creams consist of sugar of the fondant type coated with chocolate.

SUGAR WORKING.

One of the most interesting branches of this art is that of "sugar pulling," in which the still plastic mass of hot boiled sugar is pulled out over a hook into a long rope or string. This is doubled and redoubled on itself, and repeatedly drawn out until a distinctly fibrous texture is observed, due to incipient crystallisation of the sugar. As a result of this treatment, sweets made of pulled sugar have a most characteristic sheen, that will be best demonstrated by the carrying out of the whole operation before you.

The mechanical operations by which the otherwise prepared sugar is made to assume the various forms of commercial confectionery are in themselves of great interest, and will be illustrated in the demonstrations following the lecture. They do not, however, well come within the scope of the chemistry of confecfectionery.

NUTRITIVE VALUE OF SWEETS.

Not only are articles of sugar confectionery pleasant to the taste, but they also have a very high value as articles of food. Sugar is a pure carbohydrate, and as such takes rank in the first class of food substances. Four ordinary sized lumps of sugar contain as much carbohydrate as a medium-sized potato. Such sweets as consist of cane sugar must be regarded as exceedingly valuable muscle foods, whose good properties are well summed up in the words of Hutchison :—

> "It is as a muscle food, however, that sugar is of special importance. We have already learnt that the carbohydrates are probably the chief source of muscular energy, and the sugars, on account of the ease and rapidity of their absorption, are better calculated to fulfil this function than any other member of the carbohydrate group. There can be little doubt that the great cheapness of sugar [and pure and wholesome sugar confectionery] must have a favourable influence on the health and growth of children, for it ensures to them an ample supply of the body food they so much need. It has the advantage too, of being a form of food which few children are likely to refuse, and that is far from being true of fat."

In the case of starch-sugar, the dextrin contained is slightly more digestible than is starch, while with the maltose, pre-digestion has proceeded a step further. Maltose is less likely to set up stomach irritation than is cane sugar, especially in some forms of indigestion. The differences between cane sugar and starch-sugar, so far as nutritive value are concerned, are but slight, but such as they are, are in favour of the latter. When cane sugar is digested, conversion into glucose is a necessary preliminary to assimilation. It is probable that maltose is absorbed without inversion, and thus, if maltose be used as a sugar (and starch-sugar is almost completely maltose), there is no production of glucose within the system.

Fat-containing confectionery as butter scotch and toffee, are yet more nourishing than those prepared from pure sugar. In cases of defective nutrition, such sweets form in many ways an admirable and efficient substitute for malt extract and cod-liver oil, and are as a rule, taken with less repugnance by children.

Among types of confectionery which are specially distinguished for nutritive value, are the various forms of chocolate. This substance is distinguished from sugars by the presence of more or less nitrogenous matter. This matter is not however, entirely of a proteid nature; a portion is present as the alkaloid theobromine, and yet another portion consists of amides. Comparatively recently a departure has been made in the direction of mixing milk with chocolate, with the production of the new well-known "milk-chocolate." A yet further departure is that of the introduction of condensed meat extractives with chocolate. But looking for the moment at chocolate preparations as foods, one of the most striking modifications is that in which pure milk proteid is introduced. This substance has been put on the market under the name of plasmon, and plasmon-chocolate is a mixture of chocolate as ordinarily sold, with the new preparation. The following are analyses of various chocolates, the first given on the authority of Hutchison, and the remaining three by the lecturer:—

Constituents.	Plain Chocolate.		Milk Chocolate.	Plasmon Chocolate.
	I.	II.		
Water	1·89	1·04	1·22	2·36
Mineral matter	1·90	1·32	2·04	2 68
Nitrogenous matter	7·85	5·23	9·39	19·14
Fat	21·20	24·46	29·98	30·36
Carbohydrate, soluble	61·90	57·44	51·04	37·36
Carbohydrate, &c., insoluble	—	10·51	6·33	8·10
	—	100·00	100·00	100·00

Of the nitrogenous matter of plain chocolate, only about 60 per cent. consists of true proteid, and therefore, 4·0 to 5·0 per cent. at the outside, of the nitrogenous matter of ordinary chocolate is proteid matter. Taking the various analyses, the ratio of proteid to carbohydrate and fat is given below. The added nitrogenous matter, both in the milk and the plasmon chocolates, is practically pure proteid. We thus get—

	Proteid to Carbohydrate and Fat.
No. I.	5·0 to 83·1 or 1 to 16·6
No. II.	4·0 ,, 81·9 ,, 1 ,, 20·5
Milk chocolate	8·1 ,, 81·0 ,, 1 ,, 10·0
Plasmon chocolate	17·9 ,, 67·0 ,, 1 ,, 3·8

In the above Table a correction is made for non-proteid nitrogenous matter. While ordinary chocolate contains some proteid, the quantity is not sufficient to give any very high nitrogenous food value. With milk chocolate there is a perceptible increase. With plasmon chocolate the ratio of proteids and carbohydrates and fats is slightly in excess of that required for a perfect food. Further, almost half the available non-nitrogenous matter is fat. For eating as a food only this diminution of the sweetness is a great advantage. It is doubtful whether any more concentrated form of nutriment than this mixture of chocolate and milk proteid is possible, and certainly there is no other form likely to be discovered outvieing it in palatability. Such a preparation should have an immense value as an emergency ration for explorers and soldiers on active service.

[During this lecture, Messrs. Clarke, Nickolls and Coombs, Ltd., exhibited the process of boiling sugar to the crack degree, and afterwards gave a demonstration of a number of operations in sugar working and sweet manufacture. They also prepared and supplied the various specimens used in the illustration of the lecture, while for much of the description of technical processes, the lecturer is indebted to the same firm for permission to inspect and investigate such manufacturing operations at their factory.]

Miscellaneous.

INDUSTRIAL DEVELOPMENT IN JAPAN.

Although the Japanese have for several centuries been engaged in mining operations, and have exported large quantities of copper and other metals, the iron mines of the country have remained undeveloped, while each year the imports of pig iron and of manufactured iron and steel have been very large. During the year 1898 the output of iron from all the mines in Japan, amounted to 26,234 tons, this being a little less than in each of the three preceding years, but more than in any year previous to 1895. The figures for 1899 and 1900 are not yet available. It is believed that there are rich deposits of iron ore in northern Japan, an estimate having been made that there are deposits exceeding 75,000,000 tons within a radius of 60 miles from Ofunato. The ore is found in beds and veins, and contains a very large percentage of iron. The same district contains considerable amounts of sulphur and copper, and some lead. According to Consul Bellows, of Yokohama, the reasons assigned for the non-development of these mines, are (1) want of mining and engineering experience; (2) failure of the work started by the Government in 1876 (owing to insufficient fuel for charcoal pig), which discouraged others from undertaking it; and (3) the general economic depression prevailing in the country. A company has recently been started, having for its object the development of the mines. The scheme includes the improvement of Ofunato harbour, which is said to possess excellent natural conditions, and is on the eastern coast, a little more than half way from Tokyo Bay to the northern extremity of the island; the construction of 60 miles of railway to connect the harbour with the main line of the Nippon Railway; the purchase and development of mines, and the building of an iron and steel foundry, machine shops, &c. At present Yokohama is the most northerly harbour on the eastern coast, of the principal islands of the Empire, and the promoters are of opinion that Ofunato harbour, with good railway connections, would become the centre of an extensive commerce. The investment of foreign capital in such enterprises has hitherto been greatly discouraged by the Japanese laws, which made it impossible for foreigners to own land, and placed restrictions on their business operations that greatly increased the risks and decreased the profits of their investments. The mining laws have lately been amended so as to be much more favourable to foreign investors, and the hope is held out that within a short time the right to own land may be conferred on aliens. A writer in the Japanese Press is authority for the statement that aliens may, after a manner, even now become landowners. He says: "Japanese law allows what is known as the juridical person—a species of fiction by means of which foreigners can, in a sort of way, own land. This juridical personage, to whom attaches the right of owning land, must consist of two or more persons. A man and his wife can become a juridical person. In the case of A and B who have become a juridical person, if one died, and the place is not filled within a specified time, the property or the undertaking must be sold." The Japanese Imperial Government, desiring to make the country independent of foreign aid in shipbuilding, railway construction, and the supply of military and naval requisites, has commenced work on a steel establishment, for which the Government Treasury has appropriated £1,410,000. The works will cover an area of 225 acres, and lie close to the shore on an excellent harbour in the northern part of Kyushu, 10 miles distant from Moji. The grounds are connected by a branch line with the principal Kyushu Railway, and are situated close to rich coal fields. There will be three departments, each under the joint direction of two engineers, one Japanese and one foreign. The pig iron department will be fitted with coke oven and blast furnace plants, the steel department with mixed Bessemer and open hearth plants and a steel foundry, and the rolling mill department with roughing-rail mill, large, medium, and small bar mills, sheet mill, and large and middle plate mills—this department including seven sub-departments. It is intended to fit each department with all needed appliances for doing the best work. An iron foundry at Fukuoka is said to be very successful, and is turning out 100 tons of pig iron a day; and there are some very successful shipbuilding plants, but it is now necessary to import much of the raw material, and some of the fittings are manufactured abroad. The Government has also recently opened an iron foundry at Wakamutsu, has imported a large blast furnace, and expects to turn out about 120,000 tons of cast-iron annually. Many undertakings, requiring the use of thousands of tons of iron, are being held in abeyance, awaiting the dawn of better times, or the influx of foreign capital. If this can be secured, there will, it is said, be no question of an active market for all the iron the country can produce. A Japanese company has already been entrusted with the construction of a railway in Korea, and the Japanese are striving to make their country the centre of supply for China and other Oriental countries.

WOAD.

A late number of the *Banbury Advertiser* contained an article on woad by Mr. Edwin A. Walford, from which the following notes are extracted:—

An old industry appears at one time to have existed in our neighbourhood—forgotten now and out of memory, but for a name clinging to a country holding. The subject woad was in its archæological sense dealt with at a recent meeting of the British Archæological Association by Dr. Plowright, of King's Lynn. Woad or wad is grown to make woad indigo for use in dyeing stuffs, and it is yet cultivated in the Fenlands of Cambridgeshire and Lincolnshire. Mills for its manufacture are, or rather were, scattered over the country. Dues were payable in some of the old boroughs for the sale of woad; an old document, dated 1243, in King's Lynn, was quoted by Dr. Plowright as setting forth the dues to be paid. Cæsar makes mention of woad in his Commentaries, and we are familiar with it through the legendary history of our school books, wherein the early Britons are stated to have stained their bodies with its blue colour.

To Dr. Plowright's researches may be added a few local notes. At Broughton, on the bye-road leading from the North Newington Paper Mill (now a bone mill) to Broughton Castle, is a farmstead with good stone labels to its doorway. Its name, the Woad Mill, yet remains on the Ordnance Survey maps, though the mill was no doubt nearer the brook. Scarcely a mile distant is the Fulling Mill, once worked for a stage in the manufacture of cloth, but now disused. The woad plant (*Isatis tinctorea*) is quoted by Dr. George Gulliver in his "Catalogue of Plants collected in the neighbourhood of Banbury," 1841, as growing in the "fields between Broughton and North Newington," and he says "It is or was cultivated at the latter place." Hereabouts then we have had in former days fields of woad cultivation, place of preparation, and manufacture linked with manufacture in the cloth industry of the Fulling Mill — all now swept away from us save for a name. The marl of the old limestone quarries probably supplied the earth required by the fulling mill. The name *wad* is yet remembered as the manufacture of the woad mill.

It is one of the pleasant walks of Banburyshire across the Constitution-hill fields to the Paper Mill, and thence along the bye-road past the Woad Mill to the Fulling Mill. On the one side of the road is the red land, on the other side the white land; it is an old geological tale why side by side should lie limestone and ironstone which should have 200 vertical feet of clay and rock and sand between. The lane cutting leading to the mill is a pleasant place for wild flowers—Dyer's rocket and Teasel are companions of the way to the place of their former use. It is possible to find a way by the brook side and across the park to the Banbury-road.

In the confines of this one estate of Broughton were these industries carried on. It is clear that the house of Fiennes and Say were great upholders of commerce. In the days of the Plantaganets nobles and king entered largely into commercial life.

The Paper Mill is there yet. It sent out excellent paper in its day—good blue hand-made stuff—the woad had something to do with the colour, no doubt. Whether Banbury had any wad dues is a question to put to the Borough Remembrancer.

The struggles of the indigo planters of our Indian Empire to keep place to-day in competition with the German chemist seems to be something akin to the former struggle and decay of the old cultivation in Broughton field. That the East Indian planters put our indigo planters out of the market may be safely surmised. But would that have been the case had the knowledge of things been well sustained? The ebb of manufacture, the ebb of agricultural industry, the ebb of population from our rural districts, may be stayed by the will of a people determined to know and to put the word "thorough" to all branches of local craft and labour.

AUSTRALIAN COAL DISCOVERY.

Coal was the first mineral discovered in Australia, its existence having been ascertained shortly after the work of settlement had commenced on the shores of Port Jackson. This was in August, 1797. During the following month of the same year—*i.e.*, in September, 1797—coal was found to the north of Sydney. In 1799 it seems to have become customary to send regularly to the Hunter River for supplies of coal. In the early days of the State the Hunter was for some time known as the Coal River. During the last few years it has been ascertained that the Newcastle coal-beds extend under Sydney Harbour, and southward along the coast, and pits on an extensive scale are being sunk, and will soon be in active operation. The Australian Agricultural Company, formed in 1826, with a capital of £1,000,000, and a free grant of 1,000,000 acres of land, gave the first impetus to the great coal trade now carried on in the State. The charter possessed by the company conceded to them the sole right to work the Newcastle coal-beds. This monopoly expired in 1847; and since then the New South Wales coal-mining industry has reached large proportions. Newcastle, the principal coal port, not only of the State, but of Australasia, is situated at the mouth of the Hunter River, about 75 miles north of Sydney, to which city it stands second in commercial importance, although its rise has been so recent as to be within the memory of comparatively young men. The first commercial recognition of the port, which was named after its busy prototype on the Tyne, to which it presents many points of resemblance, was in 1846, when the first Sub-collector of Customs was appointed. Yet in 1899, little more than half a century later, the Customs collections were £103,212—a large sum for a young port in a free trade country. In 1861, the annual export of coal from the port amounted to 131,263 tons; in 1899 it had reached 2,478,397 tons. In 1861, the Newcastle imports amounted to the value of £35,932, but 38 years later, in 1899, the value had risen to £622,446. The total quantity of coal raised in the State to the end of 1899 was 85,969,136 tons, value £35,647,004.

Obituary.

Sir James Chance, Bart., M.A.—Sir James Timmins Chance, head of the firm of Chance, Brothers and Co., Birmingham, of which he had been a partner for over sixty years, died on Monday, 6th inst., at his residence at Hove, Sussex. He was born March 22nd, 1814, the son of William Chance, J.P., of Spring Grove, Birmingham. He was educated at University College, London, and Trinity College, Cambridge, graduating B.A. in 1838, as Seventh Wrangler. From 1859 he devoted himself especially to the manufacture and improvement of dioptic illuminating apparatus for lighthouses, and he worked with the Royal Commission of that year, to correct existing errors and deficiencies therein in the lighthouses of these islands. In 1867 he was awarded the Telford Gold Medal and Premium of the Institution of Civil Engineers for his paper on "Optical Apparatus used in Lighthouses." He was mainly responsible for the establishment of the first Volunteer Corps in the Midlands, and for 34 years was governor of King Edward's School, Birmingham. He also founded the Chance Chair of Engineering in the University of Birmingham. Sir James Chance was elected a member of the Society of Arts in 1873.

John Brett, A.R.A.—Mr. Brett, the distinguished sea-painter, died on Tuesday, 7th inst., at his residence, Daisyfield, Putney, aged 70. In the obituary in *The Times*, it is noticed that in early life he came strongly under the influence of the Pre-Raphaelite movement. An early picture of his, exhibited at the Royal Academy in 1858, "The

Stone-Breaker," was highly praised by Ruskin. Subsequently he endeavoured to carry out the principles of the Pre-Raphaelites in landscape painting. Of late years he was somewhat broken in health, but he continued to paint up to the closing hours of his life, and in the Royal Academy Exhibition of last summer he had six pictures, studies as usual, of coast scenery. He was elected an Associate of the Royal Academy in 1881. In 1893 he became a member of the Society of Arts, and was a frequent attendant at the meetings.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

January 15.—"Elliptographs, and the Application of Elliptical Curves." By Frank J. Gray, Assoc.M.Inst.C.E., F.R.Met.S. Major-General Festing, C.B., F.R.S., will preside.

January 22.—"Scientific Observations at High Altitudes." By Rev. J. M. Bacon.

January 29.—"Technical Education as Applied to Paper Making." By Clayton Beadle.

February 5.—"Jamaica." By Herbert T. Thomas.

February 12.—"Industrial Redistribution." By William Leonard Madgen.

February 19.—"The Use of Balloons in War." By Eric H. Stuart Bruce, M.A. General Sir George Wentworth A. Higginson, K.C.B., will preside.

February 26.—"Recent Inventions in Weaving Machinery." By Prof. Roberts Beaumont, M.I.Mech.E.

March 5.—"Sound Signals." By E. Price Edwards.

March 12.—"Opto-technics." By Professor Silvanus P. Thompson, D.Sc., F.R.S.

March 19.—"The Utility of Alkaline Phosphatic Manures." By John Hughes, F.I.C.

Dates to be hereafter announced:—

"The Use of Mechanical Transport for Military Purposes." By Lieut.-Col. Robert E. B. Crompton, C.B., M.Inst.C.E., M.Inst.E.E.

"Servia as a Field for Railway, Mining, and Commercial Enterprise." By Everard R. Calthrop, M.Inst.C.E., M.I.Mech.E.

"The Rural Schools of France." By Cloudesley Brereton.

"Recent Work on the Photography of Colour." By Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S.

"London Tramways." By J. Clifton Robinson, Assoc.Inst.C.E., M.I.E.E.

"Remains of the Greek Occupation of Sicily." By Dr. J. Leon Williams.

"Photographic Surveying." By. J. Bridges Lee, M.A.

"Ceuta and Gibraltar." By Major-Gen. John F. Crease, C.B.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 23.—"Bengal: the Land and its People." By Francis Henry Skrine, late H.M. Indian Civil Service. The Right Hon. Sir Richard Temple, Bart., G.C.S.I.. C.I.E., will preside.

February 6.—"The Coal Resources of India." By Professor Wyndham R. Dunstan, F.R.S. The Right Hon. Lord George Hamilton, M.P., will preside.

February 27.—"The Industrial Development of India." By Nilkanth B. Waglé, B.A. The Earl of Hardwicke will preside.

March 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By Thomas William Holderness, C.S.I., Secretary, Revenue Department, India Office.

April 17.—"Our Commercial Relations with Afghanistán." By Colonel Sir Thomas Hungerford Holdich, R.E., K.C.I.E., C.B.

May 1.—"The Past and Present Connection of England with the Persian Gulf." By Thomas Jewell Bennett.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 28.—"To the Victoria Nyanza by the Uganda Railway." By Commander B. Whitehouse, R.N.

February 18.—"The French Canadian Relationship to the Crown." By W. T. R. Preston, Chief Inspector Canadian Government Emigration Agencies.

March 25.—"The Sphere of State Activity in Australia." By the Hon. Sir John Alexander Cockburn, K.C.M.G.

April 22.—"British Commercial Prospects in the Far East." By Byron Brenan, C.M.G., late H.M. Consul-General at Shanghai.

Applied Art Section.

Tuesdays, at 4.30 or 8 o'clock:—

January 21. 8 p.m.—"The Architect's Use of Enamelled Tiles." By Halsey Ricardo. Paul Waterhouse, M.A., will preside.

February 4. 4.30 p.m.—"The History of the Rosary in all Countries." By the Rev. Herbert Thurston, S.J. His Eminence Cardinal Vaughan will preside.

March 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By Gerald C. Horsley. Walter Crane, A.R.W.S., will preside.

April 8. 8 p.m.—"Street Architecture." By Beresford Pite, Professor of Architecture, Royal College of Art, South Kensington. H. H. Statham, F.R.I.B.A. will preside.

May 6.—"The Printing and Illustration of the Modern Book." By Charles T. Jacobi.

May 27. 8 p.m.—"The Decoration of the Pianoforte." By Charles C. Allom.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

SAMUEL RIDEAL, D.Sc., F.I.C., "The Purification and Sterilisation of Water." Four Lectures.

LECTURE I. — JANUARY 13. — *Purification by Uncontrolled Natural Agencies.* — Conditions of purity—Influence of physical and chemical properties on the fitness of a water for public supply—Natural distillation—Rain-water—Secondary purification in a nature—Bacterial action - Percolation through soil—Sedimentation in surface water—Effect of agitation, air, light and animal and vegetable life—Turbid rivers —Protection of sources.

LECTURE II.—JANUARY 20.—*Controlled Natural Purification.* — Subsidence and storage reservoirs — Assisted sedimentation — Sand filters — The "Schmutzdecke"—Intermittent and double filtration —Service reservoirs open and covered.

LECTURE III.—JANUARY 27.—*Mechanical and Thermal Purification.*—Mechanical filters—Use of coagulants—Softening—Precipitation by iron—Sterilising filters—Heat sterilisation.

LECTURE IV.—FEBRUARY 3.—*Chemical Purification.* — Ozone — Hydrogen peroxide — Chlorine — Chlorine peroxide and hypochlorites — Bromine— Manganates and permanganates — Acids — Sodium bisulphate—Conclusion.

CYRIL DAVENPORT, "Personal Jewellery from Prehistoric Times." Three Lectures. February 10, 17, 24.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures. March 3, 10, 17.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures. April 14, 21, 28, May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 13...SOCIETY OF ARTS, John street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Samuel Rideal, "The Purification and Sterilisation of Water." (Lecture I.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Frank T. Bullen, "Romance and Reality at Sea."

TUESDAY, JAN. 14 . Royal Institution, Albemarle-street, W., 3 p.m. Dr. Allan Macfadyen, "The Cell; its Means of Offence and Defence. Immunity. (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Henry Bridges Molesworth, "American Workshop Methods in Steel Construction."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W. 4 p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. R. Shelford, "Observations on some Mimetic Insects and Spiders from Borneo and Singapore." 2. Mr. F. H. A. Marshall, "Variation in the Number and Arrangement of the Male Genital Apertures in *Nephrops norvegicus.*" 3. Dr. Einar Lönnberg, "Some remarkable Digestive Adaptations in Diprotodont Marsupials."

Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. Emile McMaster, "The High Plateaus of Natal: their Climate and Resources."

WEDNESDAY, JAN. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Frank K. Gray, "Elliptographs and the Application of Elliptical Curves."

Meteorological, 25, Great George-street, S.W. 7½ p.m. Annual Meeting. Address by the President (Mr. W. H. Dines), "The Element of Chance in relation to various Meteorological Problems."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual Meeting. Address by the President.

Sanitary Engineers, 19, Bloomsbury-square, W.C., 7 p.m. Presidential Address, by Dr. J. C. Thresh.

Entomological, 11, Chandos-street, W., 8 p.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, JAN. 16....Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. A. Walker, "Branches of Cherry affected by the Gnomonia Disease, with Remarks on its Effects and Climatic Causes." 2. Mr. J. E. Harting, "Photographs and Specimens of Heads of Wild Sheep, to Illustrate a Recent Suggestion as to the Use of large Horns in Feral Species."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. G. Perkin, "Myricetin" (Part II.). 2. Messrs. A. G. Perkin and S. H. C. Briggs, "The Colouring Matters of Green Ebony." 3. Messrs. E. Rutherford and F. Soddy, "An Investigation of the Radioactive Emanation produced by Thorium Compounds. I."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Henry Power, "The Heart."

Royal Institution, Albemarle-street, W., 3 p.m. D. A. S. Murray, "Recent Excavations at Delphi, and in the Greek Islands." (Lecture I.)

Historical, Clifford's-inn, Fleet-street, E.C., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Mining and Metallurgy, in the Rooms of the Geological Society, Burlington-house, W., 5 p.m., 1. Discussion on Mr. J. D. Kendal's paper, "Ore in Sight." 2. Discussion on Mr. M. H. Burnham's paper, "Continuous Section Mine Sampling."

FRIDAY, JAN. 17...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Rayleigh, "Interference of Sound."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Capt. H. R. Sankey, "The Theory of Heat Engines."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. Mr. H. F. L. Orcott, "Modern Machine Methods."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, JAN. 18...United Service Institution, Whitehall, S.W., 3 p.m. (Juvenile Lecture.) Mr. C. Jerram, "The King's Navy."

Royal Institution, Albemarle-street, W., 3 p.m., Mr. W. H. Hadow, "Landmarks in the History of Opera." (Lecture I.) (Gluck.)

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FRIDAY, JANUARY 17, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, January 20, 8 p.m. (Cantor Lectures).—Samuel Rideal, D.Sc., F.I.C., "The Purification and Sterilisation of Water." (Lecture II.)

Tuesday, January 21, 8 p.m. (Applied Art Section). — Halsey Ricardo, "The Architects' Use of Enamelled Tiles."

Wednesday, January 22, 8 p.m. (Ordinary Meeting).—Rev. J. M. Bacon, "Scientific Observations at High Altitudes."

Thursday, January 23, 4.30 p.m. (Indian Section).—F. H. Skrine, "Bengal: the Land and its People."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday Evening, 13th inst., Dr. Rideal, F.I.C., delivered the first lecture of his course on "The Purification and Sterilisation of Water."

The lectures will be published in the *Journal* during the summer recess.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors should send in descriptions of their inventions not later than May 1st, 1902, to the Secretary of the Society of Arts, Adelphi, London, W.C.

Such descriptions may be sent in under the inventors' name, or under a motto, accompanied by a sealed envelope enclosing the name, as preferred.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

MEMORIAL TABLETS.

The Historical Records and Buildings Committee of the London County Council have for some time past been considering the desirability of carrying on on an extended scale the work of indicating houses of historical interest in London, which since 1866 has been carried out by the Society of Arts. Some correspondence has lately passed between the County Council and the Society of Arts, the outcome of which is that the Committee recommended the County Council to undertake the work referred to, and the Council, at their last meeting before Christmas, adopted the recommendation. The Council of the Society of Arts have undertaken to co-operate with the Committee, and to afford it any assistance in its power to secure the efficient carrying on of the work in which the Society has been so long interested.

MEMORIAL TABLET TO MILTON.

A tablet has just been erected by the Council of the Society of Arts on the front of the factory of Messrs. Legrand and Sutcliffe, in Bunhill-row, to commemorate the fact that on this site formerly stood the house where John Milton died on November 4th, 1674. On account of the position in which the tablet is placed it has been found necessary to use a different form from the ordinary one, and it therefore consists of an oblong tablet of white terra-cotta instead of one of the usual circular form. The inscription is "Site of the House in which John Milton wrote 'Paradise Lost,' and died 1674. Society of Arts, 1901."

Milton was a thorough Londoner, and occupied several houses in different parts of the town, but his attachment to the *rus in urbe* was such that he always managed to have a garden next his house, in which he loved to sit. Whilst Latin Secretary to Oliver Cromwell and his son Richard, from 1651 to 1660, he lived at No. 19, York-street, Broadway, Westminster, which looked upon St. James's-park, and was formerly known as "Petty France." Jeremy Bentham bought this house, and added the garden to his own house, which was next door. Near to the back-attic window Bentham affixed a stone, thus inscribed, "Sacred to Milton, Prince of Poets." In 1877 this house was pulled down to make way for Queen Anne-mansions, and from that time the site of none of the houses in which Milton lived has been marked.

Soon after the Restoration, in 1663, Milton removed from Jewin-street to Artillery-walk, opposite the wall of the Artillery-ground. This is now the west side of the present Bunhill-row. Here Milton finished the "Paradise Lost," and here he died. His widow occupied the house six or seven years after his death, when she removed to Nantwich, where she died in 1727. Artillery-walk was a row of a few houses, each with a garden back and front. They were, of course, not numbered, but judging from the order of inhabitants given in the rate-books, it is practically certain that Milton's house was situated where Messrs. Legrand and Sutcliff's factory is now. During the period of the Great Plague of 1665, Milton retired to the cottage at Chalfont St. Giles, Bucks, the only house connected with Milton which still exists.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF CONFECTIONERS' MATERIALS AND PROCESSES.

By William Jago, F.C.S., F.I.C.

Lecture IV.—Delivered December 16*th*, 1901.

We closed our last lecture with a reference to the nutritive value of confectionery; the subject-matter of our present lecture is essentially the flavouring matters of the confectioner. It has not been possible to avoid touching on these in the lectures which have preceded, inasmuch as milk, eggs, butter, and sugar are all of them substances of most distinct and pleasant flavours which they confer on the goods into the composition of which they enter. To this extent, these substances perform a double function, since they are parts of the essential basis of confectionery, as well as flavour-conferring bodies. We now come to touch on substances whose primary use is flavouring, and flavouring only.

Flavoured by Fruit.

Fruit of various kinds is a most important flavouring agent in flour confectionery. Passing mention only need be made of the employment of fresh fruits in season; thus, gooseberries, currants, raspberries, cherries, plums and apples, in their respective turns, are used in the manufacture of pies, tarts and puddings. What shall we say as to the chemistry of fruits? First of all, here we have the very *sanctum sanctorum* of nature's own laboratory. Referring again to those wonderful changes which together constitute the constructive metabolism of plants, in the production of fruit, nature seems to have made her last effort in the direction of products which shall be pleasant to the senses. Fruit appeals first to the eye in beauty of form and colouring, then to the sense of smell, and last of all, to the palate.

In chemical composition, most of the fruits consist largely of water, in next highest proportion containing carbohydrates, and lastly, small quantities of other bodies as set out in the following Table, quoted from Hutchison's "Food and Dietetics":—

	Per Cent.
Water	85 to 90
Carbohydrates	5·5 to 10·5
Cellulose	2·5
Proteid	0·5
Fat	0·5
Mineral matters	0·5

The carbohydrates consist mostly of sugar, the principal one being lævulose, or fruit sugar. beside which, there are varying amounts of cane sugar and dextrose. In addition to sugar, many fruits yield gum-like bodies, to which, as a group, the name of "pectin" has been given. In unripe fruits, there is present an insoluble body known as pectose, which, by the action of a natural ferment, is converted into pectin. Pectin exists ready formed in ripe fruits, and also very largely in Irish moss. Pectin is soluble in water, and is devoid of any marked flavour and odour. Treatment with a small quantity of acid causes its solution to gelatinise. Like most other gelatinising substances, the power of thus setting or "jellying" is seriously diminished, or even destroyed by long continued boiling of its solution. A solution of apple juice, on being concentrated, exhibits this jelly-like consistency in a very marked form, and the sample of apple jelly exhibited may be regarded as a pectin jelly sweetened by the addition of cane sugar.

Fruits contain notable quantities of various organic acids, among which are tartaric, citric, and malic acids. Cellulose is also present in more or less quantity. In the act of ripening, the sugar of fruit increases in quantity, while the free acids diminish ; at the same time, the cellulose also more or less disappears.

Unripe fruit when used in the manufacture of pies and puddings is too sour to eat without the addition of sugar. Sugar may be added, and cooked with the fruit, or else subsequently at the moment of eating. Various opinions have been expressed as to the respective advantages of these two methods. When added previous to cooking, more or less of the sugar is inverted by the acids present, and the degree of sweetening action of the added sugar must evidently depend on the comparative sweetness of cane sugar, and the invert sugar produced therefrom. I recently made an experiment, in which a solution of cane sugar was divided into two equal parts, and the one moiety carefully inverted and neutralised, after which both were made up to the same volume. On being compared for taste by half-a-dozen persons, the general verdict was that, for initial taste, the cane sugar was, if anything, the sweeter. On the other hand, the sweetness of the invert sugar was much more persistent and lasting on the palate. Owing to this latter property, the invert sugar was, in its total effect, considered the sweeter of the two. In the next place, an attempt was made to decide, which had the greater "covering power" for acids, and for this purpose, each solution was acidulated with an equal quantity of dilute sulphuric acid, and again tasted. The acid flavour is very rapid in its effect on the palate ; and consequently, the cane sugar which seemed to act on the palate with almost equal speed, mingled its sweetness with the taste of the acid, and so produced a homogeneous flavour. When the invert sugar was tried, the first sensation was one of overwhelming sourness, followed by the gradually accumulating sweetness of the slower but more lasting taste of sugar after inversion. The more preferable method of sweetening the fruit of pies and puddings would therefore seem to be that of adding the sugar subsequent to the cooking. But if the full advantage of the sugar thus added is to be derived, the sugar should be in a finely divided state, and allowed to dissolve in the juice of the fruit before being eaten. It is probable that the apparently greater sweetness of previously added sugar may be due to its having been thoroughly dissolved, as against the addition of large crystals of sugar after cooking, and their deglutition without solution. The question discussed throws an interesting side-light on problems of flavour generally. Much may be due to the selection of flavours which, when realised by the palate at the same time, shall conjointly produce a favourable impression ; or if appreciated in succession, shall give a sequence of effects which is in itself pleasant. That the distinction is a real one, is evinced by the frequent discrimination of flavours into "taste" and "after-taste."

The characteristic flavour of different fruits is dependent on traces of various ethereal and allied bodies. Some of them have been identified and isolated, but many are present in such small quantities as to render their effectual examination impossible. When dealing with fruit essences reference will be made to some of these bodies.

Certain kinds of fruit are more especially used in either the dried or otherwise prepared form. Most prominent among these is the ordinary dried currant of the grocer and confectioner. The currant is not a fruit of the same type as our fresh currant of this country, but is a small grape, which when dried in the sun constitutes the currant of commerce. The smaller raisin, known as a sultana, is also a dried grape of larger size than the currant. Both these owe their sweetness to crystallisable grape sugar or dextrose. Cherries are also prepared for somewhat similar use, by being stoned and then soaked in a concentrated solution of cane sugar.

A portion only of the fruits of the orange and lemon type is commonly used in confectionery, that portion being the peel. The peel of the orange, lemon, and citron are preserved by treatment with sugar syrup, then drained, and cut into slices. Peel largely owes its characteristic flavour to the essential oils found in that portion of the fruit, and to which reference will subsequently be made.

PRESERVED FRUITS AND JAMS.

One obstacle to the regular use of fruit by the confectioner is that fresh fruit is in season for only a limited time of the year. To get over this difficulty, recourse is had to various methods of preservation. The simplest in principle is that of preserving the fruit itself without the addition of any other body. This object is effected by filling clean bottles with the whole fruit, and adding water to the neck. The bottles are then stood in tanks containing water at such a height as to submerge the whole of the bottle except the neck. The water is slowly heated until the boiling-point is reached. The bottles are then securely corked and capsuled, and if the operation be successfully performed, the contents are preserved indefinitely. To understand the principles involved in the preservation of fruit, one must first realise the causes of putrefaction and decomposition. These changes are due to the action of certain microscopic living organisms present on the surface of the fruit, and also pervading the atmosphere. If the life of these organisms be destroyed, then no putrefactive changes can occur in the fruit. The heat of boiling water is in this case found to be sufficient for the purpose, and samples of such fruit are here shown you. This preservation, without sugar, results in maintaining the fruit in a condition approximating more closely to that of natural fruit than when foreign preservative agents are added.

More usually fruit is preserved in the form of jam, since the cooking, and also the addition of sugar, are, for many purposes, of advantage rather than otherwise. If asked for a definition of jam, one might give it by saying that "jam is a cooked confection of fruit to which has been added cane sugar or other wholesome sweetening and preservative agent or agents." The public demand that jam shall be palatable and also pleasing to the eye; further, that it shall be absolutely wholesome in character and contain nothing in the slightest degree deleterious. If it fulfil the whole of these conditions, it is difficult to see where the interest of the consumer is in any way furthered by limiting the range of constituents of jam any more than is done in the case of any other confection.

In order the better to explain this matter of jam manufacture, I obtained the permission of Messrs. Pink to inspect the processes at their manufactory. The busy time of the jam maker is in the fruit season. Fruit, sugar, and if necessary a little water, are added together in a steam-jacketted copper pan fitted with a mechanical stirrer. High pressure steam is admitted to the jacket, the fruit and sugar thus boiled being continually stirred the whole of the time. The boiling having proceeded sufficiently far, the jam is poured out of the copper into a suitable vessel, and then conveyed away to the filling room, where it is placed in jars or other convenient receptacles. In practice, it is found an advantage to make only a portion of the fruit into jam during the actual fruit season. Large quantities of fruit are simply converted into pulp by appropriate pulping machines, then boiled sufficiently to thoroughly sterilise and thus preserve the pulp. Such pulp is stored until required, when it is transferred to the boiling coppers, the requisite quantities of sugar added, and the jam boiled and prepared in the same manner as with fresh fruit. Samples of pulp and of various kinds of jam are before you.

As to the chemistry of jam boiling, it follows lines already indicated in other manufacturing operations, which have been described during the present lectures. Various kinds of jam must differ according to the character of the fruit, such differences largely depending on the degree of acidity of the fruit in question. During the act of boiling, such acid inverts more or less of the cane sugar added. As was fully explained during the treatment of sugar boiling, such invert sugar exercises an inhibitory action on the crystallisation of the cane sugar also present. Therefore, the inversion of cane sugar by the acid of the fruit prevents subsequent crystallisation of the jam. The less acid the fruit contains the less is the amount of such inversion. With very ripe and comparatively non-acid fruits the requisite amount of inversion may be obtained by prolonging the boiling, since the effect of a small quantity of acid acting for a longer time is much the same as that of a large quantity for a shorter time. But too prolonged boiling introduces another difficulty —the pectin in the jam, like other analogous substances, has its setting or "jellying" properties diminished or destroyed by too prolonged boiling, and therefore it is not always feasible or advisable to push inversion by a too prolonged boiling. In the case of sugar-boiling, an alternative method to the use of acid for "cutting the grain" was described, and a specimen shown you of the prevention of granulation by the addition of starch-sugar (or starch-maltose). The jam manufacturer finds the same agent of service for the same purpose, and accordingly with some kinds of fruit, and under certain conditions, a portion of the sugar used consists of that from starch. The maltose crystallises less readily than does cane sugar, and in this way lessens the tendency to crystallisation. But the dextrin also present in starch-sugar is probably a yet more effective preventative, and exercises a very powerful retarding influence on the crystallisation of the jam. Analyses of sirupy starch-sugar have already been given you; but for confectioners' purposes, such sugar should be selected with as high an optical rotation as possible, thus showing the maximum of dextrin and maltose with the minimum of dextrose. In those kinds of jam prepared from acid fruits, no addition of starch-sugar is necessary. When very acid-free fruits are employed, the addition of starch-sugar is an advantage, and in no way lessens the palatability or wholesomeness of the jam. Recently some preparations of marmalade have been put on the market, in which the slices of fruit float in a thick, transparent, sirupy jelly. These forms appeal very strongly to the eye and also to the palate; in their manufacture starch-sugar is almost a necessity.

In jam-making, the boiling itself is a very efficient agent of preservation; but the sugar also acts as a preservative agent, since although dilute sugar solutions ferment readily, yet sugar in this concentrated form is a powerful antiseptic body.

Among things to be condemned without reserve in the manufacture of jam is the use of unsound or decomposed fruit, and also that of low grade and impure sugars, whether of the sucrose or maltose variety. These lower the quality of the jams, and render it decidedly unwholesome. Well made jam does not require the addition of formalin, salicylic acid, or other similar preservatives. The addition of artificial colouring matter is also unnecessary, although with modern harmless colours, no actual injury results from their employment.

Jam for confectioners' purposes requires to be made of such a consistency that it will readily stand the heat of cooking in tarts, &c., without becoming so liquid as to run out. This point is a very important one, and hence specially stiff jams are manufactured for use in confectionery.

Nuts, Walnuts, Almonds, &c.

Nuts are used both in flour- and in sugar-confectionery. Thus cakes are covered with a layer of almond paste. being a mixture of blanched ground almonds, finely ground sugar, and eggs. Much the same substance is known in sugar confectionery under the name of marzipan, samples of which, in various forms, are exhibited. Almonds are also used as the basis or foundation of comfits which consist of an almond centre coated in a very ingenious manner with sugar. Samples of these in various stages of manufacture are before you. Walnuts are also somewhat largely used, especially in conjunction with chocolate. Reference has already been made to nougat, and to nuts as forming one of the constituents. In some of the more expensive sweets of this type, pistachio nuts are used. These are characterised by a delicate flavour, and a light green colour, which render them very striking in appearance when introduced into confectionery.

Nuts are characterised by the high proportion of oil or fat which they contain; this amounts to from 50 to 60 per cent. of the whole nut, the remainder consisting of proteid, carbohydrate in small quantities, and cellulose. The oil of nuts is likely to become rancid on keeping; for this reason walnuts and other nuts are liable to acquire an unpleasant taste if exposed to the air. Almonds are supplied not only as the whole kernel of the nut, but also in a ground condition. In this latter form there is opportunity of considerable sophistication. Buyers of ground almonds should be on their guard against removal of oil, and addition of starch, sugar, or other foreign matters. The cocoanut is also largely used for confectioners' purpose. The nut, after removal from the shell, has the outer skin pared off; the flesh of the nut is then shredded and carefully dried. Again the purchaser should satisfy himself that no oil has been removed.

Essential Oils.

In the case of a very large number of substances, their special and peculiar flavouring qualities are due to the presence of small quantities of substances possessing the particular taste and smell in a marked degree. These flavouring matters have, in many cases, been isolated and obtained in a state of purity. In a large number of instances their physical properties are those of a volatile oil; that is to say, they are liquid, more or less oily in their nature, evolve a distinct and often powerful odour at ordinary temperatures, and boil or distil at a much lower temperature than the common or fixed oils.

From time to time one sees an advertisement in the newspapers for a "still-room maid;" it would be too perilous for a "mere man" to attempt to define and describe what the duties of a modern still-room maid may be, but the name itself is evidently a relic of when the still-room was an essential part of the domestic economy of a great country house; and at that time no doubt the maid assisted her mistress in carrying out the operations of the still-room. Associated with the by-gone still-room were the "strong waters" of an earlier age, and an old cookery book gives among its recipes—

"*Water of Thyme to ease the passion of the heart.*"

With modern heartaches and passionate strivings, it would seem that some anodyne, even provided by Old Father Time himself, in the shape of Lethean waters, would be a priceless boon, and one well deserving of preservation by our feverish generation. But the recipe so poetically named, is much more prosaic in its actual nature; the "passion of the heart" is heart-burn, and water of thyme is the result of distilling the herb called thyme, so as to get its essence as "thyme-water." The modern chemist goes a step further and gives you the same essence, still more concentrated, under the name of "thymol." In old cookery lore, we have thyme-water, peppermint-water, savory-water, which latter, by-the-bye, is not in the least savoury, and many others. Let us take peppermint as an example of one of these. The peppermint herb is cut and soaked in water in the boiler part of the well-known still; heat is applied and as the water boils, its steam carries along with it the vapour of the essential oil of peppermint. The steam is conducted through a condensing worm, consisting of a spiral tube fixed in a vessel of cold water. At the lower end, the condensed water emerges, and is found to be charged with the odour and taste of peppermint in a much more concentrated form than in the plant itself. In this way was made the old-fashioned housewife's "peppermint water."

But with this operation of distillation properly conducted on large quantities of peppermint, the distilled peppermint water is found to contain an oil which rises to the surface, and may then be separated. On these principles are prepared commercial oil of peppermint, and the manufacture of this oil may be taken as a type of that of many if not most other essential oils.

As oil of peppermint is so largely used in confectionery, some explanation of its composition should be given. The oil consists largely of the substance termed menthol, which is a crystallised solid, melting at 42° C., and an alcohol in chemical composition. This body in its free state is a well-known article, and is simply obtained by freezing the oil, when menthol separates in the solid form, and is purified from the still liquid adherent oil by pressure, or drying in a centrifugal machine. This de-mentholised oil is either sold as such, or used as an adulterant of the oil itself. Another form of adulteration is the addition of either wood turpentine or other bodies of the terpene group.

Substances commanding such a high price as essential oils offer peculiar and special temptations to the adulterator. Hence these are among the substances which particularly repay the purchaser to check by careful analysis. The following is an outline of the principles involved in such examination:—

I. Essential oils have a fairly definite specific gravity varying for the one oil with well-defined limits.

II. Many oils exercise a rotary power on polarised light; consequently like the sugars, essential oils are examined by the polarimeter. It is usual to express the results in degrees of dextro- or lævo-rotation when measured in a decimetre tube.

III. The boiling point of essential oils is fairly constant for the same oil, and so the temperature of the boiling point is also determined.

IV. The oil may contain some special compound on which its value largely depends. If this compound can be readily estimated with accuracy, such determination is an important guide in the commercial valuation and determination of purity of the oil.

Applying these principles to oil of peppermint, the following are the requirements of this oil:—

I. *Specific Gravity*, 0·910 to 0·920 at 15·5° C.

II. *Optical Rotation*, Lævo-rotary, — 20 to — 30°.

III. *Boiling Point*. The oil should not boil below 200° C., but should distil almost completely between 200° and 215° C.

IV. The menthol in the oil may be determined approximately by cooling the oil by means of a freezing mixture, and then introducing a small crystal of menthol. If the oil has been de-mentholised it remains more or less liquid, but, if pure, forms a crystallised mass through separation of solid menthol. This test is preferably replaced by an estimation of menthol by purely chemical methods.

ESSENTIAL OIL OF LEMON.

In this oil we have another of vast importance to the confectioner, and one which is also well known as the light yellow liquid of extremely fragrant odour, of which samples are before you. Unlike peppermint oil, that of lemon is not usually obtained by a process of distillation. Everyone knows that if a piece of lemon be turned inside out, particles of liquid of a pungent odour are ejected from the outer surface, a fact which is particularly appreciated in cases where they happen to enter the eye. The essential oil resides in small cells immediately below the outer surface of the lemon, and these are burst on bending the peel. For many cookery purposes, the flavouring matter is obtained by grating off the outer layer of the skin, which grating is then known as the "zest" of the lemon. The process of manufacture is conducted on similar principles. The interior of the lemon is first removed, leaving its rind in two cups; these are turned inside out, and the ejected essence wiped off the originally outer surface by a sponge. This operation is continued until the sponge is saturated, when the oil is squeezed out into a vessel, and the collecting operation continued.

In composition oil of lemon consists principally of a terpene, having an analogous composition to that of wood-turpentine, and to which the names of lemon-terpene and limonene have been given. This body differs from turpentine in that it possesses a higher boiling point and a higher rotary power than the latter. As a flavouring agent the terpene of lemon oil is comparatively of little value, the essential flavouring matter being an aldehyde, $C_{10}H_{16}O$, known generally as citral. Oil of lemon contains citral in quantities varying from 4 to 7 per cent. For some purposes the presence of the lemon terpene is considered an objection, and, therefore, there are at present put on the market so called terpeneless oils of lemon in which all or part of the terpene has been removed, and the citral with other flavouring ingredients alone remains. Such oils are prepared by a process of distillation *in vacuo;* the terpenes, having a lower boiling point, first distil over and leave behind the citral residue.

Like the other oils, there are certain requirements which that of lemon are expected to fulfil; of these the following is a summary:—

I. *Specific Gravity.* 0·857 to 0·860.

II. *Optical Rotation.* Not below + 59°.

III. *Boiling Point.* Not below 170°.

IV. On being subjected to fractional distillation, the first 10 per cent. distilled over will exhibit a less optical rotation than that of the original oil, but such difference should not exceed two degrees. This last limit is that laid down by the *British Pharmacopœia*, but the amount of such differences varies considerably in different years. Thus I have recently examined oil of undoubted purity, in which the respective figures are

Optical rotation for whole oil	+ 62·5°
Optical rotation of first 10 per cent. of distillate	+ 57·4°
Difference	5·1°

Lemon oils of the current season are giving as a rule this difference of 5 degrees.

Oils of lemon are frequently sold with the results of a direct estimation of citral given; but, for several reasons, this is no very true guide to value. In the first place, the results obtained by the rougher methods of estimating citral, may be far from accurate, and an investigation of the methods of sophistication, indicate other and more cogent reasons for distrusting citral estimations as an indication of actual value.

In earlier days, the principal adulterant of oil of lemon was turpentine, and even now samples are at times met with containing some 40 or 50 per cent. of this body. The limitations previously given will readily serve to detect adulteration with oil of turpentine, since this body has an optical rotation of from — 40° to + 20° according to source, and a boiling point of about 157°. Any large admixture of turpentine will lower the optical rotation of oil of lemon, but this can be to some extent masked by the addition of cheap oil of orange, which has a rotation of from + 92 to 98°. By boiling and fractionally distilling, the presence of turpentine is clearly revealed. First, it lowers the boiling point; and, secondly, the first fraction of distillate will have a much lower optical rotation, since the terpenes of either oil of lemon or oil of orange agree very nearly with the original oils in rotary power. It is for this reason that the limit of 2° has been laid down, although, as first stated, this is not sufficiently elastic to include all pure oils. But when a difference of as much as 12 or even 15 degrees occurs, as was the case in some of the samples exhibited, which had been recently sold by well-known firms, then evidently the buyer is being subjected to a fraud of a very marked kind. But the use of oil of turpentine is now largely superseded by adulteration of a much more insidious description. In the manufacture of terpeneless oil of lemon, lemon terpenes are largely produced as a waste product. As such terpenes constitute some 93-95 per cent. of pure oil of lemon, it will be seen that their addition cannot, very largely, alter the chemical constitution of the oil, except by lessening the proportion of the (approximately 5-6 per cent. fraction of) citral and allied constituents. Neither the boiling point nor the optical rotation of the oil is thus affected; and further, the first 10 per cent. of distillate will also agree with the standard tests. There remains the direct estimation of citral, but unfortunately, from the present point of view, oil of lemon is not the only source of citral. Verbena, or as sometimes called "lemon plant," and also lemon grass, yield oils which contain about 80 per cent. of citral, and consequently, lemon grass oil forms a comparatively very cheap source of citral. A mixture of say 94 parts of lemon terpene with 6 of lemon grass oil, will answer not only to the B.P. limitations before quoted, but also to a direct citral estimation. Therefore, the simultaneous addition of lemon grass oil as well as lemon terpenes to oil of lemon evades both the B.P. tests, and also a direct citral determination. But although such a mixture may answer to the tests mentioned it is in no way a true or efficient practical substitute for pure oil of lemon. Oil of lemon contains other odoriferous constituents than citral, which latter are not furnished by lemon grass oil; and this oil contains odorous and flavouring matters which are foreign to oil of lemon. The presence of lemon grass oil is revealed by the odour of verbena possessed by the oil, and this can fairly readily be detected by the expert. A considerable assistance in applying the "nose test" to lemon oil is to have it distilled *in vacuo* to 10 per cent. of the original volume, and then smell the concentrated citral, &c., residue either in its normal condition or after dilution with pure concentrated alcohol. In the absence of the terpenes the nose can often better judge the character, origin, and quality of the essential flavouring bodies present. When making an analysis of oil of lemon it is no very difficult matter for the chemist to return this concentrated residue of distillation to his client, and allow him to exercise his own judgment on its odorous qualities. Nobody can feel more strongly than a chemist the urgent necessity for buying oil of lemon only on analysis; but failing this very obvious precaution, the buyer may generally take it for granted, that given a range of oils supplied by one and the same dealer, he will get as good (if not the best) value for his money by selecting oils of the top quality, as by taking those of lower price. If he has a preference for diluted oils, the most economic method of gratifying it, is by buying pure oil and lemon terpene, and mixing them at his own discretion.

Other essential oils used by the confectioner must be passed over with but the slightest reference. Those already dealt with may be taken as types, and for particulars of oils of orange, caraway, and many others, systematic treatises must be consulted.

Almonds not only contain a true and non-volatile oil, but also a substance called amygdalin, which by taking up water, is converted into dextrose, essential oil of almonds, and hydrocyanic acid. The essential oil is obtained by a process of distillation, and is then freed by appropriate process from the hydrocyanic acid. Such volatile oil of almonds is essentially benzaldehyde, C_7H_6O, and has a pungent characteristic odour. This oil is employed to fortify almond confectionery, a less proportion of almonds being used, and a larger portion of sugar or other sweet bodies employed. In ground almonds, as supplied ready-made to the confectioner, this type of adulteration should be carefully watched for. It is only within certain limits that this employment of essential oil is advisable, since its too generous use gives a strong over-powering flavour, markedly different from the delicate taste of the almond itself. Pure natural oil of almonds, freed from hydrocyanic (prussic) acid, is worth from 25s. to 30s. per lb., while inferior oils and fraudulent and poisonous substitutes range in price, from 20s. to as low as 6d. per lb.

The various spices, cinnamon, cloves, &c., all yield essential oils, and these are in many ways of use to the confectioner.

Essences.—There is a more or less subtle distinction between essential oils and essences. Thus, essence of lemon is not necessarily the same as essential oil of lemon. Many essences are solutions of essential oils and other flavouring ingredients in alcohol. An illustration of these is offered by the well-known essence of mixed spice of the confectioner, and used largely in the manufacture of "Hot-cross Bun." The real flavouring matter of such essence is a mixture of essential oils of different kinds of spice; but most samples also contain alcohol in large quantities running up in many cases to as much as 80 per cent. (and in extreme instances 90 per cent.) of the total essence.

Essential oils and essences require constant supervision, and all users of any but the very smallest quantities, will find their frequent analysis to amply repay them.

Fruit Essences.—The composition of fruits has already received attention in this lecture, but as their flavouring matters are prepared in a more or less concentrated form, they require some attention under this section of our subject. There is a small class of fruits of which the flavouring matter has been identified as largely composed of one or more definite chemical compounds. Thus as already explained, the essential oil of bitter almond consists of, and is identified with, benzaldehyde. The following are other instances of chemical compounds which are the cause of the flavour of fruits:—

Fruit.	Flavouring Compounds.
Jargonelle Pear,	Amyl acetate.
Quince,	Ethyl pelargonate.
Pine-apple,	Ethyl butyrate.

By this is meant, not merely for example, that the flavour of the jargonelle pear is simulated by acetate of amyl, but that that substance is the actual flavouring body of the pear itself. For these and possibly one or two other bodies, the essential flavouring ingredients are thus obtained in a pure form from outside sources; and what is sold as essence of jargonelle pear is largely, if not entirely, amyl acetate in a more or less concentrated form.

Another group of essences consists of those of an artificial nature, built up from a number of essential oils and other flavouring ingredients, according to each particular manufacturer's recipe. Some of these are pleasant in flavour, and others the reverse; but whether pleasant or unpleasant, most of them bear but a very distant resemblance to the fruit they are supposed to imitate.

The efforts of chemists have recently been directed to conserving the natural essences of fruits in a concentrated and permanent form, and these efforts have met with considerable success. The samples placed before you as natural fruit essences are manufactured by Stevenson and Howell, Ltd., and are guaranteed to be products of the respective fruits themselves. It would be impossible to attempt here any description of the manufacturing processes; but it may be said that the raw material is fresh ripe fruit. If you take the most luscious fruit imaginable, its water, cellulose, proteids, fat, and mineral matter do not materially, if at all, contribute to the flavour. The pectin-like bodies are also flavourless, while the sugars, although sweet, are not distinctively flavouring. As these constitute the main proportions of the fruit, it is evident that a considerable concentration of the flavouring portion is conceivable, and, as a matter of fact, the solid portion of these is removed as an almost tasteless mass. It remains to drive off as much of the water as practicable, so as to obtain a strong solution of those constituents, to which belong the characteristic taste. This being done, the fluid is sterilised so as to preserve it from decomposition, and, as a result, you have the purely natural essences of the fruits.

Vanilla and Vanillin.—Turning to yet another distinctly different type of flavouring matters, we may take as an example the well-known vanilla flavour. This flavour is familiar as a result of its presence in chocolate, ices, and other confections. The actual source is the pod or fruit of the vanilla plant, of which samples are exhibited. Close inspection of these shows them to be covered with a white efflorescence; this consists of the essential principle of vanilla, which has exuded and crystallised. To this body the name of vanillin has been given. Vanillin constitutes about 2 per cent. of the pod, and like many other flavouring and odoriferous substances is an aldehyde in composition. To obtain the flavour of vanilla in the most thorough and efficient manner there is probably no simpler method than to powder the pods themselves with sugar as a diluent, say 1 part of vanilla to 9 parts of sugar. The objection to this is that in light-coloured cakes and ices the appearance of what look not unlike particles of snuff scattered throughout the substance is unsightly. To obviate this, a tincture or essence of vanilla may be prepared by macerating the vanilla in alcohol and filtering off from the insoluble matter. The solution thus obtained yields all the flavouring bodies of the pods without the presence of the objectionable solid portion.

Vanillin is one of those substances which has been artifically prepared, the process usually adopted being that of subjecting eugenol, the essential constituent of oil of cloves, to a process of oxidation. When thus prepared and thoroughly purified, vanillin consists of a white crystalline matter of an intense vanilla odour. It is important that the vanillin should be thoroughly freed from the oil of cloves from which manufactured, or else the substance is liable to have itself a distinct odour and taste of cloves. When first put on the market vanillin commanded a very high price, and in 1876 was quoted at £160 per lb., while in 1898 the price had fallen to £2 12s. for the same weight. Vanillin is liable to adulteration with various harmless but valueless substances, the presence or absence of which can be determined by analysis. The manufacturers point out that a mixture of 2½ per cent. of vanillin in sugar is equivalent in strength to the vanilla pod itself. As the equivalent of the confectioner's "vanilla sugar," they recommend that 2½ per cent. vanillin sugar should be taken in the same quantity as would be taken of vanilla itself. Vanillin forms a very useful substitute for vanilla, and from its greater cheapness is somewhat extensively used. It is doubtful however, whether for the most delicate flavouring purposes it can be considered a *complete* substitute for true vanilla. While undoubtedly, vanillin is the chief and predominant flavouring ingredient of vanilla, yet it is probable that there are traces of other flavouring matters present, and the flavour of the pod is therefore that of vanillin, *plus* such additional flavours as are given by these other bodies, which are absent in artificial or synthetic vanillin.

Reverting a moment to the essence of vanilla, while the best is prepared from fresh pods, inferior qualities consist of tinctures made from the almost exhausted residue, which are subsequently fortified by the addition of artifical vanillin.

Not only are flavouring matters employed by the confectioner, but he also finds a use for bodies which are ordinarily regarded as scents or perfumes only. Among these the otto of roses, and musk find a place in the store rooms of the larger manufacturing confectioners. They, like the essences, are bodies whose chemistry possesses an intense interest; but in common with many other topics must perforce be excluded from our present review of confectioners' materials.

And now our journey together is almost completed. We have but touched on the very fringe of our subject; and of the whole of it, that included in the study of essential oils and flavourings, their origin, nature, and uses, is to me the most tempting and fascinating. They alone could well form the subject-matter of a most interesting course of lectures; but time is imperative, and we must of necessity conclude our present work together.

I cannot bring this course of lectures to a close without acknowledging the hearty help I have received from those firms which have so kindly favoured me with specimens, and arranged demonstrations. No one but myself can form an idea of the amount of time, trouble, and expense which they have devoted to this matter, and which can meet with but little recompense beyond the knowledge of having been of service to you. I tender the whole of these gentlemen my warmest thanks.

To my audience I have only feelings of gratitude for their close and sympathetic attention in these lectures. I trust I may have said some things which will stimulate the attention of manufacturing confectioners to the chemistry and valuation of their raw materials, and the chemistry of their processes. Further, I hope that I may have succeeded in interesting the members of the Society of Arts, and through them the public, in the manufacture of confectionery, and also, shall I say, in the work-people engaged in this important industry.

At the close of the lecture, Messrs. Clarke, Nickolls and Coombs, Ltd., gave a second demonstration of sugar-working processes. Messrs. Stevenson and Howell, Ltd., exhibited a collection of various confectionery flavourings, illustrative of the lecture.

SIXTH ORDINARY MEETING.

Wednesday, January 15th, 1902; MAJOR-GENERAL E. R. FESTING, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Aitchison, James, 14, Newgate-street, E.C.
Allen, Henry Charles, River Plate House, Finsbury-circus, E.C., and 31 Maresfield-gardens, Hampstead, N.W.
Barber, Walter Maw, 20, Woodland-road, New Southgate, N.; and Toronto, Canada.
Bowles, Lionel Oliver, Tipling Ghat P.O., Dibrugarh, Assam, India.
Brenan, Byron, C.M.G., Royal Societies' Club, St. James's-street, S.W.
Chase, March F., The Mineral Point Zinc Co., Mineral Point, Wisconsin, U.S.A.
Child, Arthur Blackburn, The Galway Electric Co., Ltd., Newtownsmyth, Galway, Ireland.
Das, Radha Charan, Balasore, India.
De Fenzi, C. W. P. Douglas, Inns of Court Hotel, High Holborn, W.C.
Goodbun, John Percy, Southcote-house, near Leighton Buzzard.
Harris, Henry, Wyoming, 61, Wood-vale, Honor-oak, S.E.

Hawksley, Kenneth Phipson, 30, Great George-street, S.W.
Leeming, John, Victoria-house, 117, F.R.I.B.A., Victoria-street, Westminster, S.W.
Leeming, Joseph, F.R.I.B.A., Victoria-house, 117, Victoria-street, Westminster, S.W.
Manton, Arthur Woodruffe, B.Sc., F.R.I.B.A., Chipping Sodbury, Gloucestershire.
Menon, C. Gopal, 273 Linghi Chetty-street, Madras, India.
Mosenthal, George Joseph Samuel, 190, Queen's-gate, S.W.
Munford, J., Kensington College, 143-145, Queen's-road, Westbourne-grove, W.
Muthusawmy Iyer, C.V., Cumburn, Madura District, Madras, India.
Pownall, W. O., The Guildhall, Westminster, S.W.
Randall, Joseph, Warren-lane Works, Woolwich, S.E.
Randolph, Professor Lingan Strother, M.Am.S.C.E., Blacksburg, Virginia, U.S.A.
Roy, Kumar Ronendro Narain (Bahadur of Bhawal), The Palace, Joydebpore (E.B.S. Railway), East Bengal, India.
Stewart, J. Erskine Meysey, Gas and Electric Lighting Offices, Leicester.
Symon, Alexander, F.R.I.B.A., Arbroath, Scotland.
Thompson, Charles, J., Warren Bank, Brampton, Cumberland.
Thorne, William, Rusdon, Rondebosh, Cape Town, South Africa.
Topham, Thomas Edward, Assoc.M.Inst.C.E., Natal Government Railways, Durban, Natal, South Africa.
Willcocks, William, Cairo, Egypt.
Wood, John T., Registrar of Mining Rights, Castle-buildings, Johannesburg, Transvaal Colony, South Africa.
Young, Clyde, 6, Lancaster-place, Strand, W.C., and Bristol-lodge, Putney-heath, S.W.

The following members were balloted for, and duly elected members of the Society:—

Bullough, Sir George, Kinloch C stle, Isle of Rum, Scotland.
Clark, John Spencer, 110, Boylston-street, Boston, Mass., U.S.A.
Hepburn, Arthur Elphinstone, Soberton Rectory, Bishop's Waltham, Hants.
Heyl-Dia, George Edward, Warrington, and 32, Victoria-street, S.W.
Miller, Luiz D., The Firs, Simonstown, South Africa.
Moulvi Sayid Ashrafvddin Ahmad Khan Bahadur, Hooghly Imambara, Hooghly, Bengal, India.
Sabin, Alvah Horton, 45, Broadway, New York, U.S.A.

The paper read was—

ELLIPTOGRAPHS, AND THE APPLICATION OF ELLIPTICAL CURVES.

By Frank J. Gray,
Assoc.M.Inst.C.E., F.R.Met.Soc.

Amongst the various curves which enclose, or are displayed by the common objects of our surroundings, none, perhaps, is less generally understood and appreciated than the ellipse. The study of this curve does not form part of the ordinary school education; and it is usual to consider the construction and properties of the circle and the rectilinear figures the only part of geometry necessary for the exercise of the reasoning faculties and for building up the storehouse of knowledge. It would hardly be an exaggeration to say that only those whose vocation in after life necessitates the study of the higher curves, are expected to have a clear conception of the properties of the ellipse. It is a common error to confound the ellipse with the ove and the oval, and to use the latter word indiscriminately for the three distinct figures.

In Fig. 1 the ellipse and the ove are compared by superposition: in Fig. 2, the ellipse and the oval are treated in the same manner. The ove (XPY) is constructed in the usual way as the locus of a fixed point in a line of constant length, one extremity of which describes the circle AMB, whilst the other extremity slides along the diameter ABC. By letting fall a perpendicular MK from any point M to the diameter, and drawing KQ parallel to the diameter and equal to MP, we have a point Q of the ellipse, whose major axis is XY. It will be observed that the ove is symmetrical about one axis only, and in this respect it can be distinguished from the ellipse, which is symmetrical about its two axes.

In Fig. 2, we have the two ovals (of Cassini), ABA', CDC', constructed from the focal properties of the curve, and two ellipses constructed about their respective axes. It will be observed that the oval, like the ellipse, is symmetrical about both its axes, and may thus be distinguished from the ove. The curvature of the oval differs from that of the ellipse, and although the axes are common to both figures, the area of the oval is greater than that of the ellipse. The two ovals in the figure are drawn so as to be confocal, and it will be noticed, that the longer the minor axis, the more nearly does the curve approximate to the ellipse.

The ellipse is well-known to be one of the curves of conic sections, and we may therefore consider that it was discovered more than 2,000 years ago by Menæchmus, a pupil of Plato. He derived his curves from sections perpendicular to the slant side of right circular cones, and designated the ellipse the "section of an obtuse-angled cone," as distinguished from the parabola, the "section of a right-angled cone," and the hyperbola, the "section of an acute-angled cone." The geometry of these important curves was developed by the Greeks, and their investigations were systematically compiled by "the great geometer," Apollonius, of Perga, in his eight books on conic sections. Apollonius shewed that these curves are obtained by sections of either right or obtuse cones; and it is to him we owe the names "ellipse," "parabola," and "hyperbola."* The ellipse probably became associated with the circle as its perspective image in the 15th century, when perspective was developed by the great Italian architects. The terms, "focus" and "eccentricity," were introduced in the 16th century by Kepler; and a century later appeared Dr. Wallis' "De Sectionibus Conicis," in which the properties of conics are derived from a description *in plano*.* Apollonius used parallel chords, and distances from tangents measured along conjugate diameters in order to determine points of conic sections; and it was not until the 17th century that the method of Cartesian coordinates was introduced, enabling the geometric study of the properties of curves to be replaced by the discussion of equations after the methods of algebra.† Having briefly sketched the history of the ellipse as a conic section, we may now consider this curve in its direct relation to the circle. It seems to the author that the orthogonal and conical projections of the circle afford the most practical conception of the ellipse; for they embrace the idea of the section both of the right or oblique circular cylinder and of the right or oblique circular cone.

FIG. 1.

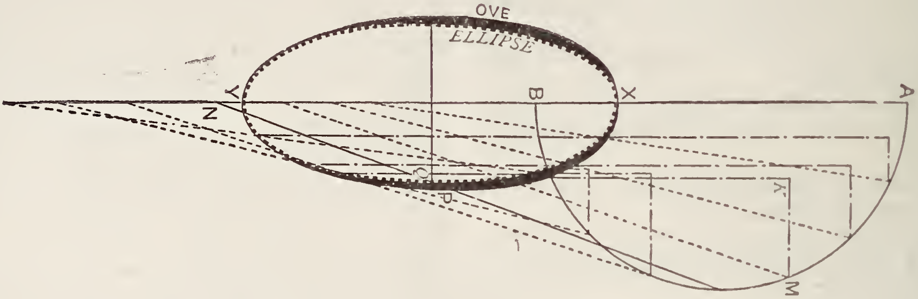
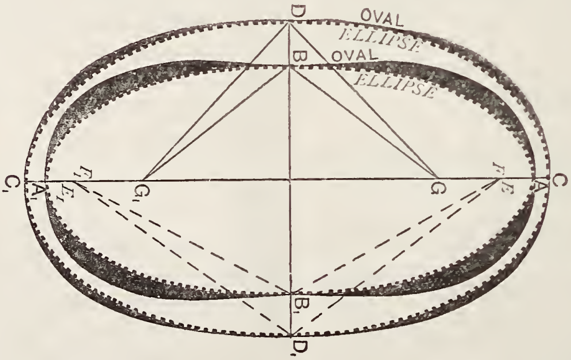


FIG. 2.



An elementary knowledge of geometry suffices to show that the ellipse is intimately connected with the circle, and that the two curves have many properties in common. Thus the equation to the circle, with the origin of the co-ordinates taken at the centre, is:—

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* Fink, Dr. Karl: "Geschichte der Elementar-mathematik."

* *Encyclopædia Britannica.* Art. "Conic Sections."

† Fink.

$$x^2 + y^2 = a^2$$

or divided by a^2

$$\frac{x^2}{a^2} + \frac{y^2}{a^2} - 1 = 0 \ldots . (1)$$

and the corresponding equation to the ellipse is:—

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - 1 = 0 \ldots . (2)$$

In equation (1), a is the radius of the circle, and in equation (2), a and b are the semi-axes of the ellipse. If we conceive the semi-axes to equal, and substitute a for b, the two equations become identical, and the circle is thus shown to be a limiting case of the ellipse. Again, if we take one of the properties of the ellipse, namely, that the sum of the focal distances to any point in the curve is constant, and if we conceive the foci to approach one another and to coincide at the centre, then we have a curve of constant radius, that is a circle. The ellipse, besides becoming a circle when the two axes are conceived to be equal, or the two foci to coincide, becomes two coincident straight lines, when one of the axes is conceived to be shortened, until its extremities coincide at the centre. This is indicated in the construction of the ellipse as a roulette (Fig. 7). In this case, if the tracing point be taken at the centre of the rolling circle, its locus will be a circle, concentric with the fixed circle; if taken elsewhere within the area of the rolling circle, its locus will be an ellipse; and if taken on the circumference of the rolling circle, its locus will be two coincident straight lines.

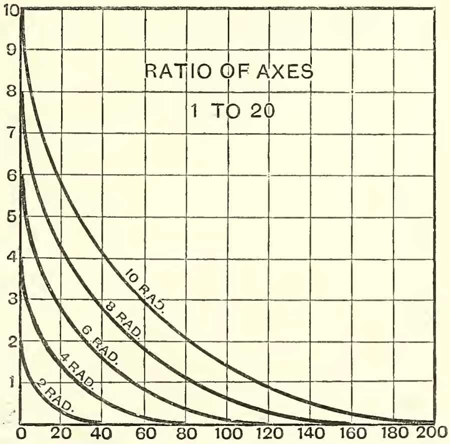
Where an ellipse is obtained as the orthogonal projection of a circle, its major axis is parallel to the intersection of the two planes, and equal to the diameter of the circle; and its minor axis is to the diameter of the circle in the ratio of the cosine of the angle made by the planes. Thus if the angle between the planes is 60°, and the diameter of the circle is 12 units long, the major axis of this ellipse will be 12 units, and the minor 12 cos. 60, or 6 units in length.

Another well-known property of the ellipse is that its area is the mean proportional between the areas of the two circles described about the major and minor axes. Conversely, the area of the circle is the mean proportional between the areas of the inscribed and circumscribed ellipse, the ratio of whose major and minor axes is constant. By applying the integral calculus we find that the expression for the area of the circle is πr^2, where r is the radius, and that for the area of the ellipse is $\pi a b$, where a and b are the semi-axes; also that, if any ordinate is produced to meet the auxiliary circle, the area of the portion of the circle cut off by the abscissa and its ordinates is to the area of the corresponding portion of the ellipse as the semi-axis major is to the semi-axis minor.

There are several reciprocal theorems with respect to the circle and the ellipse*, which are of interest to the student of the constructive geometry of plane curves; but they have no bearing on the subject of this paper, and it would serve no purpose to refer to them. Having so far outlined the relation of the circle to the ellipse, we will now proceed to consider the more practical part of our subject.

Ordinates may be obtained graphically by a simple method of geometrical construction, which can best be explained by the following diagram (Fig. 3). In this diagram we have a square divided by horizontal lines into ten parts, and by vertical lines into 200 parts, and quadrant of circles described with various radii from centres taken in the diagonal of the square. The horizontal and vertical lines represent respectively the abscissæ and ordinates to points in these circular quadrants; and if each division of these lines is read as the same unit of length, then we shall have the abscissæ and ordinates of ellipses whose axes are in the ratio of 20 to 1. The ellipse being symmetrical on both its axes, any one quadrant gives all the necessary readings for

FIG. 3.



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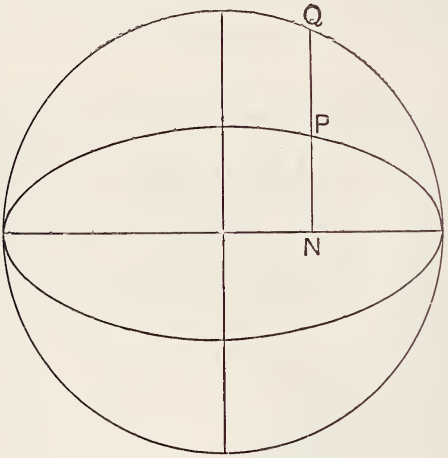
* Vide Eagles' "Construction of Geometry of Plane Curves," chap. VII.

plotting the whole curve. This method is based on the property of the ellipse, namely, that if (Fig. 4) the ordinate, P N, be produced to meet the auxiliary circle in Q, then QN : PN : : major axis : minor axis.*

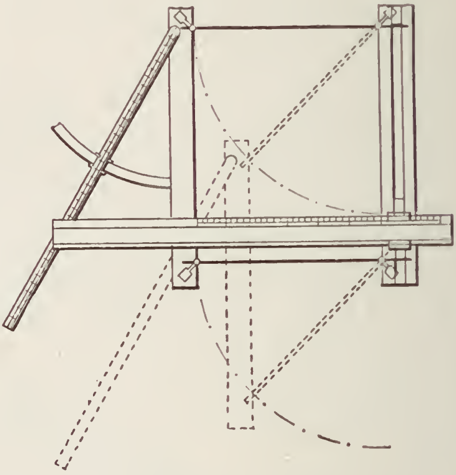
Following out this principle, and with the assistance of Mr. James Rickman, M.A., the author has devised a computing scale for giving the ordinates of ellipses of any size and eccentricity. It consists (Fig. 5) of a pair of vertical bars, connected by adjustable rods, and having a movement like that of the ordinary parallel rule, but limited to an angle of 90 degrees. One of the bars is fixed in position, and the other moves parallel to it under the restraint of the two equal connecting rods. A cross bar is held at right-angles to the bars in a slide which can be adjusted in any position along the length of the fixed bar. By swinging the moving bar to any position in the quadrant, its length and the length of the cross bar cut off by their intersection, represent co-ordinates to the circle; and it is evident that if the moving and cross bars are graduated by scales in any ratio, one to the other, the readings will give the ordinates of an ellipse whose axes are in that ratio. In order to make the ordinate scale applicable to ellipses of any proportions, without having to change the graduated bars, a proportion slant bar is added. The latter is pivotted to the top of the moving bar, and is adjusted to such an angle therewith, that it will give the required reading at its intersection with the cross bar. As the moving bar is always perpendicular to the cross bar, and the slant bar is at a fixed angle, similar triangles are made whatever the position of the moving bar, and the reading of the slant bar is equivalent to that which would be obtained on the moving bar if specially graduated. (Euclid, VI., 4.)

Fig. 4.



We will now direct our attention to the methods by which ellipses may be described.

Fig. 5.



Most of the problems in plane geometry are solvable by reducing them to those fundamental problems by which straight lines and circles are drawn and coincident points obtained. Such problems are said to be elementarily constructible; and the only drawing instruments generally used for their solution are the marking medium, the straight edge, and the compasses. By means of these instruments we are able to express the abstract idea of the geometrical point, straight line and circle, and to represent the various plane geometrical figures made up of straight lines and circles. Some geometrical figures cannot be elementarily constructed, and the problems of their construction are solvable from their definitions as loci of points, or from their known properties. The geometrical solution of any of these problems gives only one point in the curve, and every other required point is obtainable by repetition of the process under relatively different conditions. To represent the continous curve passing through these ascertained points, recourse is had to freehand drawing or to the aid of French curves. In the study of geometry this method is indispensible, for it affords valuable exercise in drawing and creates true impressions of curvature, but in practical work it is tedious and unsatisfactory. In this respect the construction of the conics and higher curves differs from that of rectilinear and circular figures. The one gives an indication only of the path of the curve, and the other is a precise and complete process. This is strikingly exemplified in the case of those two closed curves—the circle and the ellipse. Each is a locus of a point moving in a plane: the one, the locus of a point moving so that its distance from a fixed point is always in a constant ratio (less than unity) to its distance from a fixed line. To describe the one geometry assumes the use of the compasses; but for the other we are not given any describing instrument, except the string and two pins, or the strip of paper used as a trammel. It is true that it is no concern of geometry what instruments are used to draw its figures and represent its constructions; yet it is not unreasonable for the student to seek some instrument for describing the ellipse as easily as a pair of compasses describes the circle.

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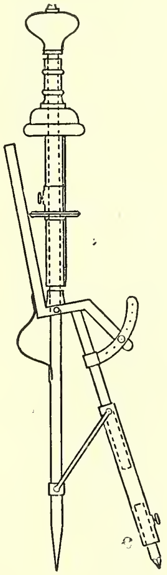
* *Vide* Rev. H. G. Day, "Properties of Conic Sections," Pt. 1, prop. XXII.

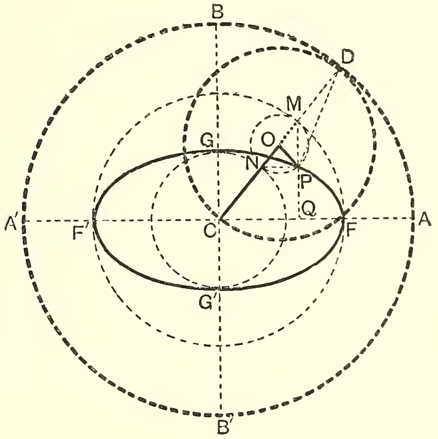
FIG. 6.



Ellipse compasses have been devised, but they have not found favour on account of the inconvenience of using them. They have elliptical templets, affixed in a horizontal position to the central leg of the compasses, for the purposes of limiting the amount of curvature to be traced by the describing leg. The instrument patented by Alfred Joseph Hale, Clerkenwell, in 1862 (Fig. 6) is on this principle. Another device of this class is the triangular compasses with a pencil-holder which slides up and down one of the legs set at an angle with the drawing surface. The pencil marks from different faces of its point as it traces the curve; therefore a drawing pen cannot be used with this method. These ellipse compasses, like those of similar size for circles, are intended only for small figures. For figures larger than about four inches by six inches the author suggests a beam compass constructed on the principle of the hypotrochoid. This well-known principle is, that if a circle roll on the inside of the circumference of a circle of double its radius, any point within the area of the rolling circle traces an ellipse.

In Fig. 7, ABA^1 is the fixed circle, CED the rolling circle, and P any point within its area. Then PQ : MQ :: NC : MC; and the locus of

FIG. 7.



the point P is the ellipse FGF^1, having for its semi-axis major CO + OP, or CF, and for its semi-axis minor CO + OP, or CG.* This construction is identical with the "two circles" method: thus, if from the extremity M of the radius of the circumscribed circle the line MP be drawn parallel to the given minor axis GG^1, and from the extremity M of the corresponding radius of the inscribed circle the line NP be drawn parallel to the given major axis FF^1, then the point P at which these two lines intersect is on the required ellipse. The equations to the hypotrochoid may be written in simplified form:—

$$x = b^1 (1 + m) \cos. \phi \quad \ldots \quad \ldots \quad (1.)$$
$$y = b^1 (1 - m) \sin. \phi \quad \ldots \quad \ldots \quad (2.)$$

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* For geometrical proof, see Dr. Besant's "Roulettes and Glissettes."

where $b^1 = \mathrm{OD}$; $m = \frac{\mathrm{OP}}{\mathrm{OD}}$; and ϕ = angle DCA; and these equations gives values for x and y identical with the following for an ellipse :—

$$x = a \cos. \phi \quad \ldots \quad \ldots \quad \ldots \quad (3.)$$

$$y = b \sin. \phi \quad \ldots \quad \ldots \quad \ldots \quad (4.)$$

where a is the semi-axis major (OD + OP), b is the semi-axis minor (OD − OP), and ϕ is the eccentric angle (DCA).*

In the suggested beam compass (Fig. 8), the beam is pivotted wherever adjusted, to a weighted base carrying a fixed pulley; and it carries at its extremity a free pulley to which the describing arm is attached. The radius of the fixed pulley (A) is double that of the free pulley (B), and the two are connected by open belting, or preferably by bevel wheels and shafting; consequently for each revolution of the beam, the describing arm makes two revolutions, relative thereto, in the opposite direction. The marking medium is carried at the extremity of the describing arm, and the length of the latter can be adjusted as required. If a drawing-pen is used, it is kept tangential to the curve being traced, by means of two guide bars: one of these is kept parallel to the beam by means of pulleys and belting, and the other is pivotted thereto and slides through an eye in the pillar of the pen. These two bars are adjusted so as to make with the describing arm a triangle similar and similarly situated to the triangle formed by the line of the beam, the line of the describing arm, and the normal from the instantaneous centre of the roulette. This triangle is DOP in Fig. 7: the effective length of the arm is PO, and of the beam CO. In setting the instrument for any ellipse the beam is adjusted so as to be equal to half the sum of the semi-axes, and the arm to half their difference.

There are many other forms of ellipse instruments besides the compass pattern, and they may be classified under four headings, viz. :—

1. The focal method.
2. The trammel method.
3. The mechanical method.
4. The projective method.

1. *The Focal Method.*—There appears to be only four devices on this plan, viz. :—Stanley's "Simple Elliptograph;" an instrument patented by H. V. Hazard, of California, in

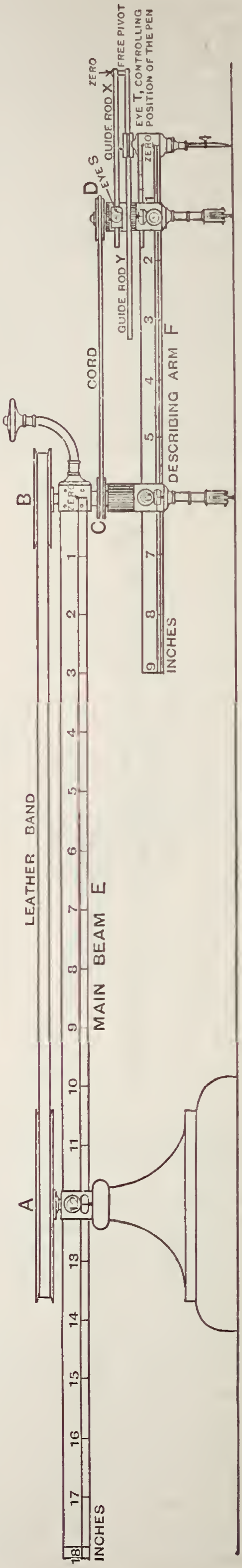

Fig. 8.

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* For the equations to the hypotrochoid, see Perry's "Calculus for Engineers."

1884; one patented in 1895 by V. E. Contonze, of Naples; and Professor Honey's device. Stanley's instrument consists of a slide rule, having two pins for foci, one at the end of the rule and the other at the end of the slide. It also includes an appliance for keeping the pencil vertical and the cord taut. A small portion of the curve is obstructed by the rule, and has to be added afterwards with the aid of a French curve. Hazard's instrument consists of a drawing pen or pencil, having an attachment by means of which a looped cord is fastened thereto, and carried round the grooved points of a pair of dividers situate at the foci. Contonze's instrument is faulty, in that the tracing point, instead of being at the intersection of the focal lines, is on a line drawn through that point from the centre of the curve. The arrangement devised by Prof. F. R. Honey consists of an ordinary T-square, provided on the blade with two adjustable eyes for foci, and on the stock with a stiff reel. A cord, passing through the eyes, is adjusted and kept tight by winding the free ends of the loop around the reel. It gives a semi-ellipse only.

The focal method is the gardener's way of marking an ellipse, and for that purpose it is well adapted; but for more accurate work it is open to objection, owing to the difficulty of maintaining a constant tension on the string.

2. *The Trammel Method.*—This is the very old and well-known device of carpenters. It corresponds with the geometrical construction of the ellipse as the locus of the extremity of a line of constant length moving, so that its other extremity and an intermediate point are always on fixed rectangular axes. It is not suitable where the axes of the ellipse are nearly equal, because the distance between the guiding points would be too short to control accurately the trammel. In such cases the tracing point may be taken between the guiding points; but this is inconvenient, as it necessitates a prolongation of the axes or trammel-cross, and then gives only a quadrant of an ellipse at each operation. Mr. Richard Inwood's arrangement is on this principle, and consists of a perforated bar, one of whose extremities slides in contact with a T-square, and the other with a set square. In using this arrangement the point of a pencil is put through one of the perforations of the bar, and thus directed, traces a quarter ellipse.*

The trammel with its grooved cross is too well known to need description. The bars of its cross are generally from three inches to five inches in length, and, therefore, ellipses can be drawn with minor axes of from 6 inches upwards. The author of the paper suggests that smaller ellipses might be described by suspending the cross and trammel from a frame above the drawing surface.

It is a curious reflection on the working of our Patent-law that two Germans, Grestav Heinel and Carl Barth were granted a British patent in 1894 for an ellipse trammel, pure and simple. There have also been patents taken out for applications of the trammel (such as that in 1890 of Michael Palmero, a French tailor, for marking out patterns in cloth) and (as that in 1888 of Thomas Smith of Southampton) for cutting out cardboard mounts. Stanley's semi-ellipse trammel is a well made instrument, having a three branched cross, and in its ordinary size capable of describing semi-ellipses with major axes of from two inches to twenty inches in length.

3. *The Mechanical Method.*—Elliptographs, which may be classified under this heading, are numerous and in many cases display considerable ingenuity in their construction. They have link motions or some combination of circular and rectilinear motions, the aggregate of which gives the curve of the ellipse. They are principally applicable to the representation of very small figures, owing to the limits imposed by the framework in which the mechanism operates.

One of the most interesting instruments of this class is that communicated to the Society of Arts in 1818 by Joseph Clement, of London. It has a radial bar which rotates under the constraint of certain sliding bars, and is capable of fine adjustment. It moreover can be used for solving other geometrical problems, and for drawing the teeth of wheels and the threads of screws. The gold medal of the Society was presented to the inventor, and a copy of the instrument ordered.* Another useful instrument is Finney's elliptograph, improved by Mr. W. F. Stanley. It is supported on a stand, and has a square sliding plate, which carries a describing arm and moves under the constraint of certain slides in grooves. It is applicable to ellipses having major axes from half an inch to six inches in length. Burstow's instrument is somewhat similar in general design. It has pulleys and chains to constrain the movement of the slides and describing arm; but in Stanley's improved form toothed wheels are used for this purpose. Grace's epicyclic instrument may also be mentioned. It consists of a train of wheels intended to give the describing arm an angular resultant motion equal to, and in the opposite direction to, the motion of the radial bar. It has an ingenious linked train of wheels which can be adjusted to suit the setting of the bar and arm. Its drawback is that a pen cannot be used as the marking medium. The elliptograph of Wilhelm Lehner—a German electrical student—is interesting on account of the "planimetrical" principle on which it is based. It describes the curve as a transformed ove, following the geometrical construction alteady explained in Fig. 1. Farey's and Hottinger's instruments are closely allied to the trammel method. Harrer's instrument may be mentioned as an example of those having harmonic motions. With such instruments, the marking medium does not travel inside the supporting frame. An objection to them would be the large space they occupy, compared with the size of the figure traced.

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* *Vide* W. F., Stanley, "Mathematical Drawing and Measuring Instruments."

* *Vide* "Transactions of the Society of Arts," vol. xxxvi.

4. *The Projective Method.*—The projection may be obtained from either a circle or an ellipse. Carmien's device gives the curve as a projection of a circle, the describing arm receiving a circular motion in an inclined plane, and the marking medium being kept vertical and in contact with the drawing surface, by means of an ingenious arrangement of hinges. Hick's instrument projects the curve from the inner side of an elliptical ring. This device was communicated to the Society of Arts, in 1842, and the inventor was awarded the silver Isis medal.* Stanley's elliptical templets are oblique sections of a cone, and can be used in the same manner as French curves.

A large number of ellipse instruments have been devised, especially during the last century, and it is impossible to notice all of them in this paper. Those mentioned are taken merely to illustrate the different methods of construction, and not in any way to suggest which are the best designs. Accuracy of delineation, size and proportions of the required figure, space available for operating, and cost, are considerations which must be taken into account in deciding which form of instrument is most suitable in particular cases.

The degree of frequency with which the elliptical curve is employed appears to be the principal point on which arguments for and against the use of elliptographs turn. Given a properly constructed instrument, its advantages over the compasses and straightedge are at once apparent. Not only have we economy of time, but neater and more accurate delineation. Now is the ellipse a common curve, or sufficiently common to justify the use of elliptographs? We will look around us, and note where it occurs.

Conjuring a mental picture of the Universe, we are at once impressed by the ellipticity which controls the motions of the celestial bodies. We see the working of Kepler's law of elliptical orbits and of Newton's law of attraction. There is the sun at one of the foci of vast ellipses, in the path of which the earth, the planets, and the periodical comets traverse space; and our globe in turn is the focus of the elliptical orbit of the moon.

Again, if any geometrical form can be assigned to the earth, it is an elliptical one. This form was deduced by Newton from the centrifugal force generated by diurnal rotation; and actual measurement has demonstrated that the length of a degree of a meridian increases progressively from the equator to each of the poles, making a meridian a nearly true curve of the ellipse. From the variation of the radius of curvature of this curve, the ratio of the equatorial and polar diameters is determined.

Passing to natural objects which we can more easily realize, we notice the elliptical curve traced in the ocean, on the coast, and by the birds of the air. In the deeper parts of the ocean, the particles of water move in a vertical plane in an approximately circular path; but in the shallower parts, and near the shore, the orbit becomes elliptical. Then the inclination of repose of the shore, that is its slope as formed by gravity and the action of heavy seas, approximates closely to the curve of an ellipse. This was first observed by the late Mr. Edward Case, who in a paper on the Dymchurch Wall, read before the British Association in 1899, said: "The natural inclination of such foreshores is elliptical, and the apron of the sea wall should, as nearly as possible, take that form, the inclination from high water mark gradually decreasing until it meets the sand at a very low angle."

Turning our attention to the aerial locomotion of birds, we shall find that the trajectory, described by any point of their wings, is elliptical. This interesting discovery was made both by Count D'Esterno and Professor Marey. The latter made his investigations by means of a pneumatic apparatus, communicating the vertical and horizontal movements of a bird's wing in flight to an arm, tracing on smoked glass. The trace is an elliptical curve, produced by the rectangular combination of two simultaneous rectilinear movements, on the same geometrical principle as that adopted by Harrer in his harmonic elliptograph. In recording continous flight the smoked plate is moved along, and the tracing becomes a looped curve, and, to use Professor Marey's words, "It may be compared to the tracing given under the same conditions by a Wheatstone's rod, tuned in unison, and giving an elliptical vibration."*

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* Vide "Transactions of the Society of Arts," vol. liv.

The curve of the ellipse and its properties enters into the laws of Mechanics, and affords graphic solutions of several important problems. It has its uses in determining bending and twisting moments, direction and intensity of stress, alteration of figure accompanying strain, and the dimensions of linear arches. In Civil Engineering we find elliptical tunnels and bridges, that is, those possessing a more or less true form of the ellipse according to the number of centres of curvature employed. For tunnels this form is generally adopted for the sides and top of the arch ring. For masonry and brick bridges this form of arch is frequently used for the greatest spans. Without going further afield than the Thames we find semi-elliptical arches of 120 to 150 feet span in Waterloo-bridge and London-bridge, and those of less than 50 feet span in Henley-bridge and Godstow-bridge. There are many important railway and other bridges possessing this form of arch in other parts of the United Kingdom and in European countries; but it would only be wearisome to increase the list. It may, however, be remarked with reference to bridges that Sir John Rennie used elliptical coffer-dams for the piers of London-bridge, in order best to resist the strong currents of the Thames.*

The ellipse is rarely met with in mechanical engineering. Professor Willis describes elliptical toothed wheels, in his treatise on Mechanism, and shows how a continuous variable motion can be obtained by them. He also describes toothed wheels, constructed in conformity with curves having elliptical lobes; and it is stated that such wheels have been successfully employed in silk mills for giving varying velocity ratios.

The elliptical curve holds an honourable position in Architecture. Judged by the canons of Art, it is to be preferred to the straight line and the circle, but falls short of being a perfectly beautiful curve. Hogarth, Owen Jones, and Ruskin have taught us that straight lines are the least ornamental; and that curved lines have a measure of beauty, in that they are subject to variation of curvature as well as of length. To be perfectly beautiful, a curve must continually change its curvature as it flows onwards, and must appear to be travelling to infinity; and although it must be governed by consistent laws, the mechanical process by which it is described must not be evident. The ellipse is imperfect in that it returns into itself after having traced four similar curves of equal length; but its curvature is not so monotonous as that of the circle, and the drawing instrument is not so apparent. These attributes, combined with its utility, indicate the adaptibility of the ellipse to construction and ornament; and we frequently find it applied to both purposes in beautiful buildings.

We also find the ellipse commonly employed in hanging advertisement boards; and elliptical picture mounts and pictorial borders are constantly before us.

But the commonest of all illustrations of the curve is the shape of the shadow cast by circular surfaces and spheres, and the perspective image given by circular objects. The latter is especially interesting because the configuration of the circle is never seen unless the eyes of the spectator are situated in a particular position relative to its centre and its plane; in every other case—and in by far the greatest number of instances—the circle is seen obliquely in perspective, as an ellipse. This is the visual act of seeing; but by an almost involuntary act of the mind, engendered by experience, the circular form is generally known to be what it is, and not what it appears to be. When we pass from the circle as a superficies to the solid which it generates—to the sphere—we find that in the latter the circular form is always presented from whatever point of view it is seen, and it does not appear to be an ellipsoid—the solid generated by the ellipse. We are continually seeing examples of this in photographs, in which wheels, balls, semi-circular arches and the like are presented in oblique perspective. And in London we have a conspicuous example of this perspective effect—one seen daily by thousands of people travelling from west to east to their daily occupation—the Great Wheel of Earl's Court.

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* Marey, E. J., "Animal Mechanism."

* "Autobiography of Sir John Rennie, F.R.S," p. 172, *et seq.*

Such are the uses of the ellipse, and such the different kinds of instruments for describing it. The curve is worthy of attention; and the elliptograph is deserving of recognition. If that conclusion is arrived at from a perusal of this paper, the author's object will be attained.

[The paper was illustrated by instruments kindly lent by the Board of Education and by Messrs. W. F. Stanley and Co., Limited. Figures of these are omitted for want of space.]

DISCUSSION.

Professor GREENHILL, F.R.S., said Mr. Gray had stated that the ellipse was looked upon by most people as a mysterious curve. He was afraid that stricture was a correct one, although it seemed a pity that it should be so considering the ellipse was seen everywhere. No doubt shadows first directed the attention of Greek geometers to the section of the cone. Without taking the trouble to make a cone, Greek geometers instructed their classes by showing students the shadows cast by a lamp upon the wall and ceiling. The general tendency of the artist in drawing the ellipses freehand was to give it too much the appearance of the oval described by Mr. Gray, the ends being made too blunt. In Fig. 4, it looked as if three of the quadrants of the ellipse had been drawn with perfect accuracy by means of the elliptograph, but the fourth appeared to have been filled in freehand, the difference being very noticeable. Mr. Gray mentioned, in connection with drawing ellipses mechanically, the difficulty of guiding the drawing pen in the right direction, and had described the manner in which the difficulty was overcome. Professor Alexander had constructed an elliptic compass with a steering tiller which guided the drawing pen in a tangential direction round the curve. When the ellipse made its appearance it was always associated with the hyperbola. There were hyperbola-graphs, but they were not quite satisfactory on account of the limited range they possessed, and could not possibly be constructed so as to describe the whole of the hyperbola. The elliptograph, like every other piece of mechanism, was a variant of the principle of three bar motion which underlies the whole principle of machinery. The elliptographs shown could be employed, by fixing the describing bar and allowing the cross slides to move, to describe the limaçon of Pascal: thus the elliptograph, merely by fixing what was moving before, could be made, on properly adjusted dimensions, to serve for describing the tri-sextrix, thereby trisecting any angle. Mr. Gray had called attention to the ellipses to be seen everywhere, especially the magnificent example at Earl's Court. At night beautiful specimens of ellipses were to be seen in the shadows thrown on the asphalte pavements in the streets by the passing wheels of carriages and hansom cabs. Not only were ellipses to be seen, but the shadows of the spokes cutting them up into a number of equal areas. Another very beautiful specimen was on view at the present time in Venus, who was now at her brightest. Venus, at her brightest, as revealed through a telescope, was crescent shaped. That fact was unsuspected, there being no mention in any of the ancient Egyptian astronomers' records of the fact that Venus had crescent shapes like the moon; Galileo was the first to discover the phenomenon with his telescope.

Colonel ALLAN CUNNINGHAM commented on the manner in which many practical and mechanical difficulties had been overcome in the various instruments shown. The use of a string and two fixed points was fatal to accurate drawing, on account of the stretching of the string, but it gave a most convenient and ready means of drawing approximate ellipses. The difficulty of holding the pen tangentially to the ellipse was very great, several instruments having failed altogether through not overcoming that defect. In some of the instruments, where the ellipse was made rather small, the body of the trammel interfered with the ellipse in the four most important parts where the curvature was changed most rapidly, those parts having to be filled in by hand. The instruments in which the pen and pencil were mounted above the table, and drew the whole of the ellipse, were beautiful mechanical contrivances. Colonel Cunningham also commented on the fact that many curves in Nature, and artificial curves, such as in bridges, were really not elliptical in a geometrical sense, but only resembled ellipses.

Mr. BOULT asked if Mr. Gray could describe the principle of the Nasmyth machine, a specimen of which was exhibited.

Mr. GRAY, in reply, said that Professor Greenhill was quite right in his surmise as to the method he referred to in directing the pen. The blades were kept tangential to the trace, that being obtained by a triangle similar to the triangle D O P, of which D P was the normal from the instantaneous centre. With regard to the practical use of elliptographs, it was quite true that there were more approximate curves in existence in works than true curves, but it was not clear to him that it was necessary to have approximate curves. He could not understand in many instances why the engineer or architect took the trouble to set out a curve by a number of centres of radii instead of setting out an ellipse itself. The Nasmyth instrument was quite new to him, and it was not known by the Board of Education who invented it. It appeared to consist of a circular disc with an arm, attached to some point which was adjustable in the disc and passing through slots which were at right angles to one another. The arm was capable of moving up and down, to allow the pencil to traverse the paper. As far as he could see, if there was only the top slot, a circle of a certain radius would be obtained; if the lower slot were used, a circle of a different radius would result. It appeared to him that those two circles were the circumscribed and inscribed circles of an ellipse, and the combination of the motion gave the ellipse about which they were described.

The CHAIRMAN said that all that was known of the instrument was that it belonged to the late James Nasmyth. If it was looked at in the plan it appeared to be a sort of modification of the trammel. Regarded in this way, it would not be found to be a very complicated instrument, although it appeared to be so when seen in the three dimensions.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Gray for his paper.

Miscellaneous.

COPPER IN NEW SOUTH WALES.

It has been recently ascertained that in the western districts of New South Wales are to be found some of the largest known deposits of copper, which, when properly worked, will aid in materially increasing the mineral output of the State. Mr. Edward F. Pittman, State Government Geologist, says there is every reason to believe that copper was the first metal to be worked in New South Wales, the earliest attempts at copper mining being probably made about 1844. Various rich deposits were subsequently discovered and sought to be worked, but in the western country the industry suffered under great disadvantages, not only in regard to the scarcity of fuel and water, but more especially on account of the great distances over which the ore or metal had to be carried by bullock-teams to the nearest railway station. In the case of the Great Cobar Mine the copper was conveyed a distance of more than 300 miles over bush tracks through country where there was frequently no grass. The cost of carriage, in such cases, amounted to as much as £42 per ton, so that only a mine of extraordinary richness could have continued working under such a severe handicap. It is hardly surprising, therefore, that most of the earliest copper mines were worked in a very unscientific manner, the method generally followed being the extraction of the richest oxidised ores, without consideration of the subsequent development of the mine at greater depths. In consequence of this near-sighted policy it followed that the mines generally closed down when the rich ore of the upper levels gave place to poorer sulphides below, and more particularly when the impoverishment was accompanied by a fall in the market value of the metal. At the present day, however, remarks Mr. Pittman, the world's increasing demand for copper, for industrial purposes, bids fair to maintain a good price for the metal, and, in view of the increased facilities for carriage, which have been, and are still, being effected, by the extension of the railways, and in consequence also of the improvements which have been introduced for the treatment of low-grade sulphide ores, there is every reason to believe that a new era of prosperity is opening for the copper mining industry in New South Wales. The story of the discovery of the rich copper deposits at Cobar is interesting. It should be mentioned that "Cobar" (or "Copar"), in the aboriginal language, signifies "Raddle" (earthy iron oxide), and, from the outcrop of the Cobar lode, the aboriginals formerly obtained coloured earth for decorative purposes; in process of time a small circular excavation resulted from scooping out the soft ochreous material, forming a catchment for water, and serving as a "native well." In 1869 two Danes, Thomas Hartman and Charles Campbell, engaged at the time in boring for water in the district, camped at the native well, and were attracted by the rusty sediment at the bottom and the blue and green stains on the sides, and, for a limited extent round it. Neither were at that time acquainted with copper ores. The copper deposits at Mount Hope were discovered in 1878, and although imperfectly worked by tributers, 5,543 tons of copper, valued at £296,656, have been obtained. The whole country for many miles around is rich in copper lodes, and in several places, Mount Allen, for instance, there is a considerable proportion of gold. A large amount of capital has lately become invested in the State copper mining industry, and with the introduction of improved methods of dealing with the ore a considerable addition to the output is anticipated. In 1900 the New South Wales exports of copper amounted to 133,305 cwt., value £468,397, representing, with 17,067 cwt. of copper ore, value £7,094, and 12,336 cwt. of copper in matte, value £25,839, a total of over half a million sterling. Many miles of country, believed to be copper bearing, remain to be prospected.

THE MINERAL WEALTH OF PALESTINE.

The following information on the subject of the mineral wealth of Palestine is given in a recent report of the United States Consul at Eibenstock, on the authority of a German mining engineer in Palestine. Valuable mineral treasures have recently been discovered in Palestine, so it may be anticipated that the industrial awakening of the Holy Land is no longer a dream. It is true that the greater part of the once flourishing country is a barren desert. The lines of communication are miserable, and traffic is unsafe away from the one railway from Jaffa to Jerusalem. The newly discovered mineral deposits lie on both sides of the Jordan and the Dead Sea. The salt deposits of the Dead Sea could be developed into an industry. The waters hold chlor-magnesium, brom-magnesium, and calisalt. Apart from this, there are the bituminous chalk springs of Nebi Musa, which contain from 30 to 40 per cent. asphalt. The most important of all the deposits is phosphate. As is well known, natural chalk phosphate, phosphorite, and coprolite are necessary for the production of super-phosphates. The latter composition and sulphur form the most important ingredient in the preparation of artificial manure. The immense fields of phosphate to the east and west of the Jordan need only better means of traffic and communication in order to ensure their development. This, it would seem is not far distant, as the Turkish Government is planning a continuation of the Jaffa-Jerusalem Railway, and steamers are already plying on the Dead Sea. According to the *Levant Herald*, Dr. Weiss, a mining engineer, sent to Asia Minor at the head of a technical commission, to report upon the mineral wealth of that region, reports that there are extensive iron deposits about Eski Shehr, all the more valuable because they lie near the surface of the ground. In the district of Bigha and in the island of Rhodes, chrome is common, and if systematically worked would, it is said, yield large profits. Argentiferous lead exists at Balia, Kermasti, and Mentesheh, and antimony to the south-east of Smyrna, particularly about Odemish. In the province of Smyrna there are two undeveloped mines of mercury. Two new beds of lithographic stone have been discovered, one near Mihalitch on the Marmora, and another to the south of Lake Apollonias. The most important coal deposits yet observed are near Soma, and a very extensive bed exists at Mantzikik, near Balia. Dr. Weiss reports that in the course of his examination of the country he has discovered many veins of iron ore, manganese, arsenic, copper, tin, and marble.

COAL IN SYDNEY HARBOUR.

The successful working of a large coal mine on the shores of Sydney Harbour gives that port a new and unique position, enormously increasing its value and importance, from both an industrial and commercial point of view. The history of the undertaking is of much interest. As far back as the year 1847 the Rev. W. B. Clarke, the eminent Australian geologist, believed in the existence of coal underneath Sydney, for in that year he gave evidence before a select committee of the New South Wales Legislative Council on "Coal Inquiry," and in his evidence he is reported to have said:—"If we take a dip of only one degree from Newcastle to the south and from Illawarra to the north, the synclinal curve will meet at the entrance to Broken Bay, which is exactly half-way (the extremity, probably of the minor axis), at a depth of 4,680 ft., the depth of the coal seams, if continuous."

In 1866 Mr. J. Mackenzie (ex New South Wales State Examiner of Coal Fields) delivered a lecture in Sydney, and made reference to the probable existence of coal under Sydney. Bores were subsequently made on the shores of Sydney Harbour, and in the vicinity of the city, with varying success, but all tending to prove the existence of an immense bed of coal, estimated at many million tons, under the bed of the harbour. Ultimately the Sydney Harbour Collieries, Limited, was formed in England, with a nominal capital of £500,000, with a view to securing from the Australian syndicate the mining rights held by it, the State Government claiming a royalty of 6d. per ton on large coal, and 3d. per ton on small coal. After experiencing many difficulties in securing a site, sinking operations were commenced on June 9th, 1897, at a point facing the entrances to the Parramatta and Lane Cove Rivers, and opposite the great Government docks at Cockatoo Island, and the equally-large private docks in course of construction at Woolwich, the configuration of the site in its natural condition being that common to the unimproved shores of the harbour, steep cliffs rising from the water's edge, thence receding by rugged, rocky slopes. On November 21st, 1901, coal was struck at a depth of 2,880 feet, but the main seam lies about 50 feet lower down. By the time the main seam is reached, over a million sterling will have been expended in sinking what may be regarded as the deepest shaft in the southern hemisphere. But if the cost has been great, the reward to be secured promises to be a rich one, the body of coal at command being estimated at about 113,000,000 tons. When in active operation, the colliery will enable Sydney to have a cheap and plentiful coal supply of its own, and also enable the largest vessels to be coaled rapidly by means of staiths, without any necessity for proceeding to Newcastle and other coaling ports of the State.

MINERAL WATERS AND SPRINGS OF FLORENCE.

Mineral waters are to be found in the commune of Bagno di Romagna, Doradola, Montaione, Terra del Sole, and Castrocaro. The springs of Bagno di Romagna rise out of the banks of the River Savio from sandy rocks belonging to the eocene formation. The water has a temperature of 110° Fahrenheit, and is of an alkaline reaction. Baths of it are said to be very efficacious against rheumatism, arthritis, and cutaneous diseases. The muddy deposits are also used for the so-called mud baths. These springs are worked by The Stabilimento Termale di S. Agnesa in Bagno. Consul General Percy Chapman says that the mineral springs existing in the commune of Dovadola are two, one iodic, and the other sulphureous, saline-iodic. The first is used internally, as well as for baths, and is said to be very effectual in the various forms of disease which arise from scrofulous diathesis, for which iodine is a specific remedy. The second which has its origin from a small torrent called Rio di Piandera, is of a crystalline transparency and perfectly colourless until exposed to the air, when it becomes imperfectly opalescent and whitish. In the commune of Montaione there are the sulphurous waters of Mommialla, which are cold, whitish and so gaseous that they seem to be boiling, they are said to be useful in the treatment of cutaneous diseases. The Pillo springs contain much chloride of sodium and other salts. Their water is said to be an excellent purgative and diuretic, and very useful in liver diseases, jaundice, &c. The Luiano water is also gaseous, laxative, and is useful in cases of general debility, and especially in constipation, dyspepsia, &c. In the commune of Terra del Sole and Castrocaro there are three springs, the most important being the bromo-saline-iodic, known in commerce under the name of Castrocaro mineral water. The water issues out of a locality called Rio (a rivulet), or Rupe (a rock) dei Cozzi, and is collected in wells. The water is used in a bathing establishment at Castrocaro, and sold either in its natural state or reduced in salts,

Obituary.

ADMIRAL SELWYN. — Admiral Jasper Henry Selwyn, who died on December 31st at his residence, Gloucester-terrace, Hyde-park, aged 82, was a member of the Society of Arts of thirty-seven years' standing, having been elected in 1864. He was the second son of the Rev. Townshend Selwyn, Canon of Gloucester, and rector of Kilmington. He entered the Royal Navy on January 23, 1834, and for his conduct as mate of the *Sulphur* (Captain Edward Belcher), during the operations on the coast of China, particularly at the capture of Canton, was promoted to the rank of lieutenant on October 8, 1841. He subsequently served in the Mediterranean, the west coast of Africa, and the south-east coast of America. He received his promotion to the rank of captain in 1858, and retired from active service in 1868. Admiral Selwyn took the chair on several occasions at the Society's meetings, and frequently joined in the discussions on the subjects in which he was specially interested, more especially those connected with patent laws and with liquid fuel.

SIR THOMAS LEA, BART.—Sir Thomas Lea died on Thursday, 9th inst., after a short illness at his residence—the Larches, Kidderminster. He was born in January, 1841, and after being educated privately, entered on a commercial career at Kidderminster in the spinning business, to which he succeeded in due course, and which is now carried on as a limited liability company, under the name of Lea, Limited. In 1868 he was elected M.P. for Kidderminster), and subsequently he sat for South Londonderry, till he retired from Parliament in 1890. He was created a Baronet in 1892, and was elected a member of the Society of Arts in 1869.

General Notes.

SPORTING EXHIBITION AT ST. PETERSBURG.—According to the *St. Petersburg Gazette*, the programme of the first International Sporting Exhibition which is to be held at St. Petersburg in May and June next, has been approved by the Russian Ministry of Finance. The organising Committee is presided over by Princess Lobanow-Rostovsky, and the exhibition will include articles connected with all the known kinds of sport.

PORCELAIN VIOLINS.—A notice of the manufacture of violins and mandolines from porcelain in *Kuhlow's German Trade Review* is quoted in the *Board of Trade Journal*. A manufacturer of the Messein okarinas and porcelain organs has invented a process for the manufacture of violins and mandolines from clay. Some violins have already been completed, and the inventor has applied for letters patent for the same in different countries. The porcelain body, it is claimed, is better able to produce sound than a wooden one, since it co-operates in the production of sound, making the notes soft and full. The musical sound of the mandoline is likewise stated to be improved. In shape the porcelain violin is an exact imitation of the wooden instrument, but, as the porcelain violin is very suitable for decoration, it is very likely that costly instruments of luxury will be asked for, as is the case with the okarinas. It is asserted that the porcelain violins possess the further advantage over the wooden ones that they are totally insensible to the influence of the weather. That the porcelain violins are liable to breakage, and that they are heavy, appears to be have been left unconsidered. They are made in the earthenware factory, Sornewitz.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 22.—"Scientific Observations at High Altitudes." By REV. J. M. BACON. R. H. SCOTT, F.R.S., will preside.

JANUARY 29.—"Technical Education as Applied to Paper Making." By CLAYTON BEADLE. CAPTAIN EDWARD PARTINGTON, J.P., will preside.

FEBRUARY 5.—"Jamaica." By HERBERT T. THOMAS.

FEBRUARY 12.—"Industrial Redistribution." By WILLIAM LEONARD MADGEN.

FEBRUARY 19.—"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A. GENERAL SIR GEORGE WENTWORTH A. HIGGINSON, K.C.B., will preside.

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E.

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 23.—"Bengal: the Land and its People." By FRANCIS HENRY SKRINE, late H.M. Indian Civil Service. The Right Hon. SIR RICHARD TEMPLE, Bart., G.C.S.I.. C.I.E., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 28.—"To the Victoria Nyanza by the Uganda Railway." By COMMANDER B. WHITEHOUSE, R.N. SIR HENRY M. STANLEY, G.C.B., will preside.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

JANUARY 21. 8 p.m.—"The Architect's Use of Enamelled Tiles." By HALSEY RICARDO. PAUL WATERHOUSE, M.A., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

SAMUEL RIDEAL, D.Sc., F.I.C., "The Purification and Sterilisation of Water." Four Lectures.

LECTURE II.—JANUARY 20.—*Controlled Natural Purification.*—Subsidence and storage reservoirs—Assisted sedimentation—Sand filters—The "Schmutzdecke"—Intermittent and double filtration—Service reservoirs open and covered.

LECTURE III.—JANUARY 27.—*Mechanical and Thermal Purification.*—Mechanical filters—Use of coagulants—Softening—Precipitation by iron—Sterilising filters—Heat sterilisation.

LECTURE IV.—FEBRUARY 3.—*Chemical Purification.*—Ozone—Hydrogen peroxide—Chlorine—Chlorine peroxide and hypochlorites—Bromine—Manganates and permanganates—Acids—Sodium bisulphate—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "The Purification and Sterilisation of Water." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. D. J. Blow, "The Architectural Discoveries of 1901 at Stonehenge."

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Dr. R. Logan Jack, "Artesian Wells in Queensland, and their beneficial effects as sources of water supply and irrigation."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. Lambert, "The Mammoth Cave of Kentucky."

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. H. B. Wheatley, "English Illustrated Books."

TUESDAY, JAN. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Halsey Ricardo, "The Architect's use of Enamelled Tiles."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. Macfadyen, "The Cell; its Means of Offence and Defence." (Lecture II.) Immunity.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. H. B. Molesworth, "American Workshop Methods in Steel Construction."

Statistical, 9 Adelphi Terrace, W.C. 5 p.m. Sir John Glover, "Tonnage Statistics of the Decade 1891-1900."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. L. Lewis, "On some Rude Stone Monuments in Yorkshire." 2. Dr. T. H. Bryce, "On a Group of Cairns with Megalithic Cists in the West of Scotland, and the Human Remains associated therewith."

WEDNESDAY, JAN. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Rev. J. M. Bacon, "Scientific Observations at High Altitudes."

Geological, Burlington-house, W., 8 p.m. 1. Professors S. H. Reynolds and C. I. Gardiner, "Fossiliferous Silurian Beds of the Clogher Head District." 2. Prof. W. J. Sollas, "Analysis of Rocks."

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

THURSDAY, JAN. 23.. SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. F. H. Skrine, "Bengal: the Land and its People."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. G. Russell, "English Sacred Musicians."

Royal Institution, Albemarle-street, W., 3 p.m., Dr. A. S. Murray, "Recent Excavations at Delphi, and in the Greek Islands." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. E. B. Wedmore "Earth Currents derived from Distributing Systems."

FRIDAY, JAN. 24...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. H. G. Wells, "The Discovery of the Future."

North East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.40 p.m.

Clinical, 20, Hanover-spuare, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. James Swinburne, "The Factors of heat."—Part I. 2. Mr. Eustace Large, "Exhibition of some twinned Crystals of Selenite.

SATURDAY, JAN. 25...Royal Institution, Albemarle-street, W., 3 p.m., Mr. W. H. Hadow, "Landmarks in the History of Opera." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, January 27, 8 p.m. (Cantor Lectures.) Samuel Rideal, D.Sc., F.I.C., "The Purification and Sterilisation of Water." (Lecture III.)

Tuesday, January 28, 4.30 p.m. (Colonial Section.) Commander B. Whitehouse, R.N., "To the Victoria Nyanza by the Uganda Railway."

Wednesday, January 29, 8 p.m. (Ordinary Meeting.) Clayton Beadle, "Technical Education as applied to Paper Making."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

Dr. Rideal, F.I.C., delivered the second lecture of his course on "The Purification and Sterilisation of Water," on Monday evening, 20th inst.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, January 23, 1902; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., in the chair.

The paper read was "Bengal, the Land and its People," by Francis Henry Skrine, late H.M. Indian Civil Service.

The paper and report of the discussion will be published in the next number of the *Journal.*

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

PRIZE FOR INDUSTRIAL HYGIENE.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

Intending competitors should send in descriptions of their inventions not later than May 1st, 1902, to the Secretary of the Society of Arts, Adelphi, London, W.C.

Such descriptions may be sent in under the inventors' name, or under a motto, accompanied by a sealed envelope enclosing the name, as preferred.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the full award is sent in.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, January 21, 1902; Paul Waterhouse, M.A., in the chair.

The paper read was—

THE ARCHITECT'S USE OF ENAMELLED TILES.

By Halsey Ricardo.

The architect's use of enamelled tiles may be classed, for convenience sake, into three divisions according to the purposes for which he uses them—either on hygienic grounds; for the purpose of saving or reflecting light; or for decoration. These three divisions blend and shade off, of course, into each other, and sometimes all three objects are obtained simultaneously in one scheme of tile-work. Thus the staircase hall in Lord Leighton's house presents a wall whose surface can be thoroughly and easily cleaned; whose glaze checks the diffusion of air, dirt and moisture; retains its light and colour even in the darkest corners, and by its pattern and hues constitutes a beautiful scheme of decoration. More often a combination of two requisitions only is secured, as in the case where tiles are used to line underground passages, railways, lavatories, dark rooms, and courtyards. In a dairy, to take another example, the decorative as well as the hygienic aspects of the case are sometimes considered. But for to-night I shall pass by the builders' and plumbers' use of the material, and shall consider mainly the employment of enamelled tiles as a mode of decoration. Incidentally for this form of decoration I shall claim the collateral advantages it affords both as regards the economy of light, and the wholesomeness of the practice of covering one's walls with an impervious glaze, but the decorative treatment is what I shall most concern myself with, considering its use and the limits of its use, and what should be the architect's attitude in regard to this method of architectural enrichment. In referring to the examples of tile work in the past, I shall allow myself some latitude in my definition of an enamelled tile, for I shall want to cite the Assyrians' use of glazed bricks, the Persians' treatment of glazed terra-cotta, and the Della Robbias' of glazed earthenware — but the differences which are so apparent, are not essential, as they arise from the nature of the material. A glazed brick is only a thicker tile and a glazed plaque but a wider one. An enamelled tile, then, is a slice of terra-cotta with its face glazed, with white or colouring matter put on it or in the glaze. As a rule, the terra-cotta foundation has a distinct colour of its own—which shews through and modifies the effect of a transparent stained glass poured over it. To obviate this—when the simple result is undesired—there are two methods generally practised: one, to render the glaze partially or entirely opaque, by the admixture of oxide of tin—the other is to mask the surface of the terra cotta with a film of white ware or porcelain (technically known as slip) and on this to flow the glass. The difference, in effect, of these two methods is very striking—comparable in terms of water-colour painting, to the use on the one hand of transparent tints, on the other of body colour. In the first instance, the brilliancy of the hues and the subtlety of the gradations depend upon the whiteness of your paper: that is your highest light, and every tint you lay on it, causes so much diminution of brilliancy. So with the slip-faced tile, the white porcelain face is your highest light, and the more brilliantly white it is, the more brilliant show the colours of your stained glass upon it; it is the light reflected from the ground behind the glass, that brings out the glory and the splendour of the dyes. So it is, precisely, with transparent enamel work on metal: the more brilliant the ground, the richer and more beautiful the enamel.

With painting in body colours, the nature and colour of the ground is unimportant—brown paper will do—the brilliancy of the finished effect depends upon the purity of your white paint. So with opaque enamels, whether upon metal or terra cotta, the brilliancy must be in the glass itself, the ground contributes nothing to the effect. The glass face to the tile is one of the difficulties in tile manufacture. It has to be melted on the tile, brought to a viscid state like treacle, and by rights both the glass and the terra-cotta should contract equally on cooling. But they do not; and the addition of a white ware slip complicates matters. Consequently cracks, generally minute but sometimes serious, occur in the glaze—known in the trade as "crazing"—and may be classed under two heads, those that, occurring in the thickness of the film, still do not actually split it, and those that really divide the glaze, and in consequence expose the body of the tile to the elements. In many cases the "crazing"—where the cracks do not come through the glaze—adds a quality and charm to the tile. The walls of the fissures on either side slope at an angle, and catch and reflect the light, giving a lustre and a sparkle to the tile. But where the "crazing" is thorough, it is an evil, for it renders the tile unfit for use if exposed to the weather, and even for internal use, the beauty of the tile is gradually dimmed, because the cracks in time get filled up with a fine siltage of dirt, and the effect is that of a black cobweb sullying the surface.

The question of using tiles externally is made very difficult by the doubtful behaviour of the tiles themselves. It is a common sight to mark great patches on walls, where tiles have been, and have dropped off—to find them cracked and discoloured. The Underground Railway here is painfully rich in examples of their failure, and I note that the linings in the Twopenny Tube are beginning to discolour. Wet, followed by frost, with an imperfect key for fastening at the back of the tile, accounts for the downfall in most cases, whilst the impure atmosphere of London endeavours to discolour everything that it cannot corrode. In Mr. William De Morgan's opinion, tiles made on the "dry" system—*i.e.*, of clay ground dry, and compressed into shape by hydraulic pressure—are unable to withstand the action of frost when damp. The particles are in such a juxtaposition that the tile is soon saturated with moisture, and when this crystallises, there is no room for the expansion of the water, and consequently the ice breaks up the tile. By the "wet" system—when the clay dust is mixed with water, and pugged and variously handled, before it is dry enough to go into the oven, the disposition of the particles of clay allow for some expansion of the moisture that has soaked in, which enables the ice to be formed, without doing damage to the tile or its cement backing. Fixing is often imperfectly done—and, unless the fixing is perfect—that is to say, absolutely solid over the whole area of the back of the tile, its detachment is only a matter of time. Tiles made by the "dry" process keep very true in shape, throughout all the steps of their preparation—which is by no means the case with those made by the "wet" process—and this accuracy makes their fixing much easier, and when a wall is being tile plated with a view to protection from the weather, or reflecting the maximum of light, a close joint is a desideratum. Too much stress, however, I think, is generally laid upon this fine joint and even surface, and the tile-work is apt to look mechanical in consequence. We lose much of the inherent qualities of our materials in our attempt to secure an excellence that really does no justice to them, and which has as its chief merit that it saves labour and ministers to our convenience. Now, as regards the necessaries of our lives, these be great and real excellencies. To be able to build a wall rapidly and well with bricks that can be equably and truly laid, set in mortar mixed, and mixed most efficiently, in a mortar mill is a true convenience, and all thought to that end is thought worthily expended. But when we come to the luxuries that is another matter. If you cannot afford to have them done well, why have them at all? It is their excellence that is the justification of their expenditure. And these not quite first-class luxuries defeat their own ends. They are not luxuries unless they amuse and interest us, and how can the blind fingering of a machine tell us of anything beyond its inhuman perfection? Compare a slab of marble, hand-polished, with one that has been polished by machinery. In the first instance, the surface is full of life and movement; the light falls on its tiny depressions and irregularities, awakening wayward reflections, strengthening and palliating its colours, developing its lustres and translucencies, so that it becomes rich in story as well as in hue. In the other there is the dead level of polished surface, unassailably perfect, but, comparatively speaking, uninteresting. The life and vivacity of the marble are gone; it is merely a polished record, with the pleasant part of its individuality rubbed away into a wearisome uniformity. So it is with the machine-made wood panelling, with which we decorate our rooms and halls. From lack of any other special qualities, its mechanical excellence becomes an offence, and we hang pictures on it, and back furniture up against it, to mitigate and interrupt its exasperating uniformity. So with mosaic work. To keep the tesseræ equal and to set them all to one level face, is to renounce the great quality of life in one's work, and to throw away much that constitutes the charm of the material. With tile-work, the same holds good. A great sheet of exact shaped tiles, with dead true faces, irreproachably fixed on a dead straight wall (such as one sees at the Wallace Gallery, Hertford-house), is sad misprision of the qualities of the material. The want of thought in the arrangement, the presence of mechanism both in the design and the facture (I can hardly use the word *manu*facture, for the hands only guide, they do not make) makes the result a bore, and oppressive from the consciousness that it must have been expensive. That all tiles should be made by the wet process and all be hand-painted, is asking, in these days of economical production, more than the circumstances demand; but we might narrow our requirements down to these few particulars, and refuse to allow ourselves to be tempted to enlarge them: that all tiles should have a sufficient key for fixing; that they should be coated with a glaze that protects them from injury by dirt, acid, or attrition; that those which are to be used for external purposes should be able to withstand the weather; and that when a printed pattern has to be put on its face, that pattern should be of a very simple character, so that its mechanical repetition may be as little tiresome as possible. In firing a batch of tiles, there are generally some variations in the intensity of the colours, &c., and where the pattern is very simple these discrepancies become fairly marked, and when judiciously assorted help to alleviate the regularity of the printed design.

There are various shifts that may be legitimately used to temper the exorbitancy of hand labour, such as stencils, printed outlines, and so forth, but the cloven hoof is apt to peep out from amongst them. And the larger the area of repetition the more marked becomes the mechanical regularity of the design: a tile used in a single series down the side of a grate hardly betrays the method of its colouring, but a square yard of them blurts out the story beyond any possibility of suppression or disguise. Where cost is a consideration, and a large quantity of space is to be covered, use plain coloured tiles, and encourage such processes as exhibit the humours and behaviour of the kiln. The glory of a tile is its colour—the pattern is little more than a set of pegs on which to hang these colours, and to cripple one's effect by unnecessary care upon the skeletons of one's figures of beauty is a miserable misapplication of force. So much, then, as specification of the tile from the decorator's point of view, and of the chemistry of its clays, of its glass, and the methods of handling and firing, I shall not here concern myself; but with the application of the finished article, and that not so much from the utilitarian point of view as from the decorative.

It will be as well, I think, to glance briefly at what has been done in the past, and at examples of what are acknowledged to be masterpieces in the way of tile work, when the art of tile-making and tile-using was at its height. To do this at all adequately is out of the question this evening, and it is only by severe and reluctant pruning that I can contain myself within reasonable limits. I must begin with Egypt because the Egyptians began first. They discovered a stone that would stand glazing, and they used glazed wall decortion extensively. The Tell-el-Yahoudi plaques are to all intents and purposes wall tiles, and their date is 1400 B.C., and Dr. Flinders Petrie has discovered glazed wall tiles, of a still earlier date, amongst the ruins of the palace erected by Ku-en-aten in his newly-founded capital. The colours mostly have disappeared, owing to the action of the damp during the centuries wherein they lay buried. When the Egyptians used polychrome decoration on their plaques, the different colours were let into the object, making it a kind of tile mosaic—not painting, as in a picture, on the surface.

The discoveries at Susa mark an advance in the art of wall decoration. During the Achæmenian dynasty the royal palace had its walls adorned with panels of painted plaques, but these were rather bricks than tiles, and the methods employed were derived from the glazed bricks employed in the architecture of the Babylonian and Assyrian empires. The walls were built of light grey and light rose, unglazed, bricks ranged somewhat like the walls of the Ducal Palace at Venice, whilst the ornamented parts, which were the portals and great entrance staircases, were in enamelled terra-cotta bricks, the colours being separated by what appears to be a vitreous wall, something after the manner of the metal walls of cloisonné enamels. Darius gave up the use of terra-cotta and employed a kind of concrete for his bricks, because he found the enamel wore better on the latter.

From Susa it is but a short step into Persia. In Mesopotamia the Medes built the town of Ecbatana. Up the sides of a steep hill rose the seven circular walls, one inside the other, enfolding the treasury and the king's palace. The outer wall was of immense diameter, and the terraces enclosed by each ring carried collections of country houses with small farm and gardens attached, rather than the suburb building to which we are accustomed. The city was consecrated to the great powers of the firmament, and the devotion of its founders was registered in the form and colour of its walls. The battlements to the outer wall were white; to the next black; the third scarlet; the fourth blue; the fifth orange. The two last walls had their battlements silvered and gilt. Returning from an expedition or from the chase there stood before the eyes of the beholder the city of his home, voicing in its chord of colour the seven great orbs that guarded his family and hearth—the sun, the moon, and the five planets—who rose and set in ceaseless vigilance to call him to action, to give him rest, to bring forth meat for him and the kindly fruits of the earth; and when the fever of life was over to proclaim to him by their silent march overhead through the vault of heaven the immeasureable might of fate and the tranquillity of the grave.

This profusion of colour and metal work strikes us as extravagant, even in conception, not to speak of realisation; but in Herodotus' time he was writing of facts well known to many of his readers who had seen Nineveh and Babylon and the pictured splendour of Egypt; and this is how he describes Ecbatana. Amidst this wealth of artificial colour grew up the art of Persia, as we know it, and its influence throughout the past has been very subtle and far-reaching. It has coloured India and the shores of the Mediterranean. It is impossible to look at the Moorish work of North Africa and of Spain and not feel the Persian influence exhibited, nay more, most of the work must have been done by actual Persians carried in the train of Arab conquerors. The art of Byzantium played upon it and probably deeply influenced it, but our knowledge of Byzantine art is at present too imperfect to let us pronounce definitely in this direction. The stream of merchandise that flowed through Persia brought with it samples of the porcelains from far Cathay, and, after a certain date Chinese influence on the Persian potter is very perceptible. In China coloured tiles are largely used in exterior work. The "Porcelain" tower at Nankin (destroyed 1853) was so called because the lowest of nine stories was covered with glazed brick, the eaves over the balconies were roofed in with green tiles and the window jambs plated with glazed porcelain modelled in relief.

In the Middle Ages, and outside the sphere of Persian art, there was tile-making—but the tiles so made were for pavements and later on for roof coverings. The floor tiles were made glazed but the glaze soon wore away. Innumerable examples of these abound in England and on the Continent, made, I imagine, to reproduce as well as might be the splendours of the marble pavements abroad about which the pilgrims spoke when they returned from Rome and Byzantium or from their crusades in Paynim lands. When the revival of letters and classic lore and antique art set in, every craft was touched by its influence, and pottery had its renaissance as well as sculpture. But the tile-makers drew their new inspirations, not so much directly from the past, as from Spain, and thus in this roundabout way came under the influence of Persia. The Arabs invaded the Peninsula of Spain, A.D. 711, and remained there, so far as their influence of the tile trade is concerned, till 1610. The Alhambra was begun in 1272, and the tiles that decorate it are the oldest and most interesting in Spain. Their repute widened, and Spanish tiles spread far and wide; they were imported in considerable quantities to Genoa, to Naples, and to the islands westward of the Peninsula of Italy, and, in company with the European craftsmen, found a market in India.

During the period of the Renaissance, various attempts were made to develop the qualities of glazed ware in the direction of architectural employment, the work of the Della Robbia family being the products perhaps the most generally known. Famous factories were established at Florence, Faenza, Gubbio, and many other places under Italian rule; and under the Spanish in the Balearic Isles, and at Naples. So famous were they, that they gave a name to their ware that lasts to this day. Faience is Faenza ware, Majolica is the pottery that comes from Majorca. In the Spanish Peninsula, the Renaissance found a special state of affairs. To the south, in what was once the Sultanate of Cordova, Moorish traditions and Moorish craftsmen still lingered on, distinct from the Christian workers who were absorbing their territory; and these rival potters had occasionally blended, so that besides the Christian and the Morrisco styles, there was a third style that went by the name of Mudejar. It was not till the time of the Great Emperor Charles that the influence of the Renaissance began to show on Spanish work—the painted tiles date from the 16th century. Talavera was then the famous emporium, and its goods supplied the country, Portugal and the far East.

In England, glazed plaques, other than paving tiles, are rare. There is an interesting specimen in Lingfield Church, Surrey, an effigy of the time of Henry VIII. in glazed tiles. The figure is incised on a rather coarse red clay covered with a greenish glaze now much worn away. It is supposed, however, that the tiles are of Flemish origin. Similar instances of sepulchral portraiture are fairly common in France.

By the time we are reaching the 16th century, tiles in Europe—except for pavings and skirtings—are ceasing to be architectural adjuncts, and becoming—or trying to become—more and more tile pictures. It was the flood tide of the painters, and painters who prided themselves on their versatility. Every material was pressed into their service, mosaics, stained glass, tiles, pots, plates and dishes—all were to come out as pictures regardless of the qualifications and the limitations of the material. In Spain, the Spanish Netherlands, and the two Sicilies, this picture painting was taken light heartedly—the humours of the material were allowed to have their say, and there is a general air of not being on your oath in the treatment of these panels. If you recall the subject of a set of Dutch tiles, you will see a kind of ease in the handling and a liberal acceptance of the imperfections of the ware—altogether different from the tense serious treatment of a Maestro Giorgio tazza. The result that these (to use the loose and inaccurate but generally accepted appellation) Dutch and Spanish tiles persist to this day as living things, whilst the solemn works of art are to be found now only in museums; and we can observe how hopelessly dead the art of them has become, by the imitations of them that are being here and there manufactured. These finished picture-tiles fulfilled no real want; and as soon as the great burst of enthusiastic appreciation of all forms of craft was over, and the wave of studio excellence abated, they dropped out of circulation. Nobody would have—of such things—any but of the very best, and the very best were not being made. Even the other, more homely, efforts shared in this discouragement and soon sank to a serviceable level, such as lining dark walls and those surfaces that were likely to get discoloured by smoke and dirt; and on these terms they are made and used to this day. The high standard of draughtmanship and design had this mortal disadvantage that the artist, to gain this excellence, had to devote his whole force and attention to the pictorial side of his craft and so became divorced from his material. The tile was no longer treated on its own merits, and its decoration evolved therefrom—but as a field for the painter's display, and to secure effects which, though proper and natural in frescoes and easel pictures, are foreign to the nature of a tile, and can only be extorted—and then but partially—by the utmost technical ability.

In the East, and that part of Europe under Persian influence—as regards the potter's craft—the aim was different. The qualities of the clays and glass were accepted as the basis for development and improvement, and all advance, both in the substance and the technique, was evolved from the tile itself. Nor was the standard pitched either too rigidly or on too high a plane. The ideal was not beyond the reach of the craftsman, and there was no thought of the presence of some superior imported personage who should invest, with the garniture of Art, the product of the potter's labour; and yet, on those terms, we have examples of consummate work—supreme in technique and in beauty. And this Art is still alive, and if it could be left undisturbed, would go on quietly fulfilling its purpose. Unfortunately the restless activity of modern life, with its eager but ignorant appreciation of foreign work, is battering at its door, and we are all busied by our patronage, to change "the changeless East." European—and I am afraid English—influence, has in its blind admiration for the Art of Japan, ruined it. It set up a huge and feverish demand, and the Japanese at once set themselves in haste to satisfy it. Other nations in the East are not so mercurial and consequently have not been so much effected, but they have not been uninfluenced. Both India and Persia, not to speak of other countries, have set themselves to serve the British markets, and to conform to British standards. It may be inevitable—it is certainly disastrous. It is sad to think, with all our good intentions, how destructive we are of all those qualities we talk so glibly about, destructive because we are ignorant of what is the essence and purpose of the qualities we call Beauty and Art. At this moment, we are not agreed as to what constitutes beauty, and what is the function of art; and in our perplexity, whilst attempting to preserve and enlarge the influence of beauty, we do actually eliminate it, whilst we are agreed to transfer art from the practical side of life, and to view it as a kind of varnish which only the cultured can acquire, and the leisured enjoy.

During the past century we worked ourselves up to a consciousness of the beauty of the works of the Middle Ages in England, our Gothic monuments in especial. We set to work to preserve these beauties, and not knowing wherein they consisted, we replaced them with restorations; consequently, nearly all of the chief examples, and an immense number of the smaller, are examples no longer. In place of the original, with its history and its beauties, we have a replica which is a modern and silent forgery.

Another common instance of ignoring what constitutes the actual charm and beauty of a thing, is when some traveller discovers a little spot that has been left untouched by the modern excursionist. Struck with its peace, and the beauty that comes from centuries of quiet contention with, and mastery over, Nature, and anxious to share his discoveries with others, and thus add to their happiness, he shouts aloud in the highways and market-places the beauty of the village he has found, and the simple content of its inhabitants. The ring of enthusiasm in his voice reaches many ears. Next year the village is invaded. A toad-stool growth of cheap lodging-houses springs up, and attractions (so-called) are constructed. The railway sprouts out a branch line, and a station is dumped down cheek by jowl beside the church. The place is now easily accessible, and hundreds can now enjoy the refreshing solitude and idyllic simplicity of the place. Only, the solitude and simplicity are gone. So with our improved methods of transit, our facilities of commerce, and our demands, too important to be disregarded and too urgent to be properly executed, we have brought Oriental wares within reach of the humblest, but the beauty and excellence of the stuff is fast disappearing.

Let us review some examples of the architectural application of enamelled ware in times before the advent of the railway, and before the influence of the connoisseur was less universally diffused.

And now, what is the moral of all this ? One thing that can hardly have escaped notice is the nature of the country in which the examples that you have seen occur. Both in Persia, Tunis, and in the Spanish Sierras we are in the presence of arid wastes. Outside the towns there are no trees, no pasture. There is the blue sky over us—but till twilight too blinding for the eye to contemplate. No doubt there is a colour in the vault of night that can scarcely be imagined by those that have not seen it ; but, speaking generally, there is no colour about these cities but what is of man's nurture or manufacture. The spring brings a flush of blossom and a short-lived wealth of verdure—enough to exemplify what luxuriance of colour means. But for the greater part of the year the landscape is a sober, drab affair, with little moisture in the atmosphere to temper the brilliancy of the sunshine. The great function of these enamelled tiles, then, was to catch the fleeting glories of the fields and gardens, and, Orpheus-like, to fix them as "a lasting spring." Both by their design and their colour they recall the starry meads, and their wondrous varieties of hues and the lush luxuriance of their verdure.

In the Persian work this is more directly pictured than in the Spanish : but in both the instinct is to secure, by carpets, embroideries, tiles, and stained glass, an entourage of colour.

In this country, colour is perennial with us—it has its tides—its ebbs and flows—but even at its greatest ebb, we are encircled with tender russet and purple tints from the woodlands, and from the ploughed fields; the pastures keep a greenness; the hedgerows an intricacy of innumerable tints; the hillsides are shaggy with copse wood, and fledged with pines; sheets of water reflect, in intensified colours, the vegetation that surrounds their margins, the trees that stand sentinels beside them, the hills in whose lap they lie, and the blue of the sky overhead, and into every nook and fold in the landscape the witchery of the atmosphere flings a veil of mysticism, blending and suffusing the colours. At the call of spring the pulse of nature stirs and quickens ; the fields put on a richer green ; the cloud snow retreats, melting, giving place to the earth snow of the daisies and blackthorn, and the pale amber of the primrose. From thence to midsummer the land is one glory of everchanging colour, the beauty of bud and blossom succeeding each other in limitless profusion, and reluctantly yielding to its successor. We look out on a garden of living enamel. After blossom comes harvest, the harvest of the field and then of the orchard close, and the trees begin to don their heraldry of gold and bronze and scarlet, vying with the pageantry of the sunset in the skies. Strange swirls and wreaths of dreamy vapour hang indolently about the downs, the woods lay down thick carpets of crimson and copper beneath the beech trees and pine stems, the holly dons a glossier green, and tricks itself out in its bravery of vermeil. In this kaleidoscope of colour about us, the need of artificial colour is less insistent. We have but to open a shutter or draw a curtain, and we disclose a painted window. But it is otherwise in our large and crowded towns; there Nature's restless activities are confined in space and checked in growth. Year after year the seasons renew themselves, and with the seasons, the impulses in branch and herbage. But the privation of light caused by our high buildings and our narrow streets, the acids and impurities of our atmosphere cripple and scorch the tender growths, and degrade the freshness of their tints, till at last a film of grime reduces the green of summer to an inky grey, and obscures and sullies the yellow of decay, so that we view the complete ruin of the foliage as a desirable riddance, and are thankful to have the fallen leaves swept up and consumed as promptly as possible.

For half the year our city is the colour of a dirty cobweb, and the only refreshment the eye gets, is in the glimpses of the sky overhead, the shop windows and the hoardings. These latter mark the hunger for colour significantly. The posters, so far as advertisement is concerned, might as well be in plain black and white, but they fairly wallow in colour. Often this chromatic carnival fails in effect, but the failure is due to ignorance of how to obtain the proper value, not from any sparingness in the application of the tints. And this liberality of colour is provided, not out of generosity or exuberance of advertisement, but to supply a felt want. We want colour in our streets; we have tried for it by using coloured building materials, paint, creepers, and flowers in window boxes, and we have gone to the cost of all these endeavours, not merely to gratify our own cravings in the matter, but for the pleasure of the passer-by in the street. But these ventures are generally disconnected attempts, and so are on too small a scale to make any distinct effect, and owing to the nature of the materials they soon sink back into the general dinginess of the surroundings. Why not plate your building with tiles? I do not suggest that a man should veneer his vertical section of a street-side that serves him as his house, and let his neighbour on either side follow or not his novel start, because colour to be effective, in such circumstances, must be in broad masses. I should like to see whole streets treated in permanent colour, and please myself with the hope that some day they may be so, but as a beginning in so bold an experiment I should like to see the scheme tried on a detached building, standing free and with some trees about it, or a public building of such a frontage as should be sufficient to display a large mass of plain wall surface. We have tried spots and panels of colour here and there in our streets already, and they have failed from the timidity of their employment and the insufficiency of their area. The colour must be laid on in a broad bold mass, and pattern used only sparingly, if at all. The windows and other openings should occur in a field of plain colour, or some simple chequer or trellised diaper, and the limits of the tiling should be bounded by bands and trimmings of glazed terra-cotta. I specify glazed terra-cotta, because in building you must not mix perishable and imperishable materials together. Whilst the one is toning, softening, and decaying under the blunting hand of time, the other is merely getting dirty, and each time the front of the house is cleaned the tiles come up as fresh and bright as the day they were fixed, whilst the corroded framework must remain with the grime that age has brought it. This permanence is not so great an evil as at first appears. Much—say one-third—of a house front consists in any case of imperishable materials, such as the glass windows and the woodwork, which are renewed periodically with coats of paint, and whilst the remainder of the house is toning into a dingy uniformity, the harmony of the frontage is, every few years, disturbed by the freshened appearance, under the painters' hands, of the parts required by the covenants of the lease, and thus making of the harmony a painful discord. It is true that where the materials are all indestructible the kindly agency of time can play no part, the building is never any better than when it leaves the contractors' hands, except for the history that gradually humanises its walls. But this view of the ameliorating power of time belongs to our timid age, the age not of creation but of selection, and is by no means a healthy one. We are afraid to risk anything, and why? because we are so self-conscious, because we are so eaten up with our sense of responsibility. Not so came the models which we copy into being, although at this moment the style of the past most in vogue is perhaps the most self-conscious that we could have chosen, and (for this follows) the one that is the most disdainful in its refusal of colour. The love of colour and the power to apply it is characteristic of youth—of the youth of nations as well as individuals. Colour is the accompaniment of romance, of poetry, of enthusiasm, of abandon. Before the cold paralysis begotten of experience that we call wisdom, colour pales and fades away. The best, and by that I mean the most inspired work, is done in youth, and the colour then is the richest and most eloquent—though some there be, like Gian Bellini, or to come nearer home, Mr. Watts, who retain their colour faculty right on into old age. In youth a nation has the courage to court failure or rather to regard it as a passing circumstance in its attempt to grasp the ideal. For what to them was failure but the stepping stone to new effort? So much experience brought to them so much new knowledge and suggested so many fresh possibilities. Not only the science of architecture but the beauty which is the cream and bloom of science, grew up from the careful observation of building disasters, and the invention of expedients that might obviate their recurrence. The conditions of the time and the temper of the people determined the actual forms of the building, so that, for example, we get in one case Classic, in another Gothic architecture, but these styles were living only so long as failure was allowed to be possible and experiments encouraged. When that ceased the art of architecture became a recapitulation of past examples, the science their reconstruction or adaptation. Why should we fear to cover whole streets in

London with coloured tiles? Is there anything to lose? The streets at present are not beautiful nor are they interesting. The modern ones have no single architectonic quality. There is no general principle of design in them, no uniformity, style, composition, balance; a few good examples of designs occur in the general welter, but they make no effect on the whole, which mainly expresses private obstinacy, tinctured with selfishness. What could be gained by a broad treatment of colour is periodically shown to us when the Quadrant at Piccadilly gets repainted. In that fine sweep we have an idea, unanimity of design, and breadth of colour, and, in consequence, it is one of the pleasantest things one can meet in one's tramp through town. It may be objected that to incrust whole streets with enamelled tiles would be a very expensive business, and that the decoration, whether we liked it or not, would—owing to the cost involved in applying it—be permanent. I will take the latter objection first. It would, I hope, be permanent. Any scheme, reasonably comprehensive, simple and straightforward, must be a distinct improvement on the present polychromatic distraction, gradually surrendering its distinction under the obliterating coating of London grime. No other surface wears so well. Stone perishes rapidly. Brick and terra-cotta get incurably befouled. Marble requires frequent repolishing. Granite endures, but unless it be polished it also gets very filthy. But a good glazed tile, glazed brick or faïence, should be as durable as a plate-glass window, unaffected by the wildest acids that infest our atmosphere.

Then as to cost. Of course, tiles by the acre come expensive. But there is another side to the matter that we may as well consider. At present our buildings, in order to get the contrasts of light and shade—colour, in short—are covered with ornamental features, such as mouldings, pilasters, window trimmings, cornices, balustrades, and the like architectural upholstery, and adorned generally with a profusion of inferior carving. Now, although all this architectural frippery is pretty cheap stuff considering; still, it does cost money, and by the use of colour we can dispense with the bulk of it. The projecting cornices and sills, the carving, and features generally, form so many shelves and nooks for the dust, dirt, products of coal combustion, and the unhydrated acids enveloped in them. The rain comes and washes the collected dirt against the brickwork, whilst the liquid acids proceed to eat away the stone. Besides, these big projecting cornices are for the purpose of casting deep shadows—the very last things of all that we want in our streets. In tile work we can reproduce this effect and count upon its loyal service, whereas in our stone work the effects of light get reversed by the soot, our high lights become the deepest blacks, and the soffits, that should be in shade, are the brightest parts of our mouldings. So that in a colour scheme, with tiles, the value of projections is got by patterns and particular dispositions of tint, and all that is wanted, besides the tile work, are slips of some glazed material to act as boundaries to the fields of colour. There is another virtue in tile work, besides its being imperishable and easily cleaned, and that is, that it is impervious to the elements. There is not the same necessity to load up our girders with thick masonry walls to keep out the weather. A thin glazed skin is sufficient for this purpose, and our walls will be dryer and warmer as well. The ordinary brick wall is nearly as thirsty as a sponge-cake, and after a heavy rain-storm there is an immense amount of water to be vapourised before the walls can become dry and warm, and the weight of this water is considerable. With a glazed skin beyond the comfort of unchanging temperature, so much firing to dispel water will be saved. Moreover, the rain, instead of dirtying the house will help to clean it, and after each shower the bulk of the filth, disease germs and acids, will be washed into the drains, and be got rid of comfortably.

But there is more to be done with tiles in the way of external decoration, than merely to put them on the fronts of buildings. There are bridges, walls and fountains to be considered. Glazed brick makes an appropriate casing to the concrete arches of our modern bridges, and the spandrels might be most effectively treated with fine civic heraldry executed in tiles. Then as to our public places; take Trafalgar square for an instance. At present it is an arid waste, grey and ineffective, with various disconsolate grimy black statues attempting to ignore the presence of the two steaming fountains which mark significantly the proximity of St. Martin's baths and washhouses. Let us imagine it taken in hand and made to serve some pleasant and useful purpose, and, so far as we can, beautiful. We will begin by reducing the inordinate size of the basins to the fountains, and lining them with turquoise blue tiles, and by stipulating that for the future the fountains shall spout clear water. We will lay the whole of the area, except a fringe to the south of the necessary paths, which shall be of Purbeck stone, with turf, and jealously keep the hoof of the loafer from off it. The statues shall be cleaned up and either kept clean by frequent scrubbing, or gilded. Gordon's statue should be moved nearer to the North Wall, and the number of future statues permissible and their positions, at once determined, so as to present an intelligible scheme : the wall serving for a background. This wall we will treat for the most part in plain colour, so as to form a quiet backing to the statues—but beneath the parapet we will have a row of hatchments, the arms of those who have done good service to the State and who were connected with that neighbourhood. Beyond and above this base of colour rises the National Gallery, made the richer by this coloured setting. At present we quite waste our statues by the inappropriateness of the sites chosen for them. Standing in the midst of the confusion and turmoil of our crowded streets, they form pathetic objects helpless in the torrent of the traffic, or else they are stranded against some building and absorbed in the conflicting detail of their background. The monument is made regardless of the site, and as nobody in authority seems to care, it is dumped down on the first convenient spot handy, where it may divide with overshadowing lamp-posts the duty of dividing the traffic and imprisoning the pedestrian.

Of the internal application of tiles there is not much for me to say. A good deal has been done in this direction of a very interesting description, but by the nature of the case most of the examples were conditioned by special circumstances. An early example of the decorative treatment of tile work can be seen in the refreshment and grill rooms at the South Kensington Museum, and examples of Mr. Waterhouse's treatment of tiles may be seen in his various public buildings, banks, and insurance offices. Mr. Butterfield, in several of his London churches, was also a pioneer in this species of decoration, though the tiles he used were for the most part those mis-named encaustic—rather than the enamelled ones. Subsequently Mr. Aitchison built the Arab Hall for Lord Leighton, using for the most part the collection of old Oriental tiles that Lord Leighton had procured, and decorating the staircase hall with mainly new ones, but in admirable sympathy with the old. Outside the specimens of old tiles in the British and South Kensington Museums, a more beautiful example of Persian tiling is not to be seen in England. Leighton-house also helps to dissipate the rather general idea that a tile surface must look cold and uncomfortable, for nothing can exceed the air of protection and richness, that even the plain tiles on the staircase give. Since then, the practice of using tiles for internal decoration has increased immensely, though more in what are known as business premises than in private residences. It is, consequently, for the external use of colour decoration that I would specially plead, and for the decoration to be of a permanent kind, got either by enamelled tiles, glazed faïence, or mosaic. The French have already made some excursions into this field, notably at the Paris Exhibition, and are still pursuing the subject of building in steel and terra-cotta. It is a matter, I think, of deep regret, that at the Victoria and Albert Museum, South Kensington, where so plucky a start was made in using materials that withstand our climate, and carrying them out with so much interest and beauty, there should now be abandonment of the spirited departure, instead of development ; and that there should be a reversion to the tame respectability of stone. One might have hoped that in a new building, for new purposes, and on so large a scale, every opportunity would have been taken to advance one step further the architecture of the present day, and since the occasion seemed so suitable, to erect an example of coloured architecture. The result of this stony disdain, this proud scholarship of our streets, is that we can't live in them. Every evening thousands upon thousands escape by every railway from these masterpieces of correct architecture and superfine sculpture to the shelter of the country, where the earth is green about them and the heaven blue above them. Cannot we make our streets a little more kindly and comforting to those poor prisoners who cannot escape ? We have tried mass and form and light and shade, might we not now have an attempt at colour ?

[The paper was illustrated by a series of lantern slides, and by cartoons of Sir Edward Poynter's designs for the decoration of the grill room of the Victoria and Albert Museum, lent by the Board of Education.]

DISCUSSION.

Mr. Lewis F. Day, referring to the tile work in the Alhambra, said he did not think people realised how entirely it was mosaic. He himself did not until he went to Spain. Practically, all the Moorish tile work in the Alhambra was a mosaic of bits of tiles—a kind of work which could not be done with our hard modern tiles—those used in the Alhambra were made of a soft, friable material, which was cut up and filed into shape. At Cordova he had seen men shaping tiles in that particular way. He believed that English tiles could not be filed into shape in that way, even if one could afford to do it. He was quite certain, from his observations on the spot, that the mosaic was used simply because the people had no means of getting various colours on the same tile; they had not arrived at that time at the knowledge of how to put various coloured glazes on to one tile. When they did arrive at that knowledge they proceeded at once to imitate the mosaics. The first specimens of Spanish regular square tiles were in direct imitation of such mosaic. The reader of the paper had alluded to the pleasant effect of colour in some of the geometric schemes of decoration, and pointed out that they were pleasantly broken in colour, and not mechanical. That was quite true; but, for his own amusement and interest, he traced out a great number of the patterns, and in every case he found that in the elaborate and apparently accidental colouring of those Spanish patterns there was a system of colouring which was perfectly and mathematically exact, although intricate. There was nothing of the casualness which Mr. Ricardo apparently admired more than he did. Personally he preferred that the effect the artist arrived at should be reached consciously and not by accident. In conclusion, he expressed his admiration for the literary quality of the paper and for the delightful series of views with which it had been illustrated. The views had given him a much clearer impression than he had before of the extent and elaborateness of the tile decoration of Persia.

Mr. H. H. Statham said he did not share Mr. Ricardo's views in regard to the connection between the bare nature of the country and the colour. He had always felt that the sun brought out colour in art just as it did in flowers. When there was bright sunshine strong colour would be found in the architecture. He did not know why that should be so, except that colour told more in a clear atmosphere and under a bright sky. It would also be found that where strong colour existed in architecture there was a scarcity of mouldings and a flat treatment. He thought there was more to be said for moulding and shadowed architecture than Mr. Ricardo was inclined to admit, although no doubt attention should be directed more to colour. He had one or two practical objections against the extensive use of glazed coloured tiles recommended by the reader of the paper. He did not very much like the idea of street architecture with a glazed surface; if a colour was obtainable without the glaze he would be better pleased. There was also the difficult practical question of how to harmonise the fronts of houses, considering that each front was under a different ownership. Were the district surveyors of the future to go through a practical examination as to their eye for colour, in order that they might inform each proprietor which colour should be applied so as to harmonise with the colour of his neighbour's front? Although he did not look to quite such an extensive application of coloured tiles as Mr. Ricardo suggested, they might be used, if not over the whole front, at all events, as points of colour and ornament in a most effective manner.

Mr. W. Aumonier thought that Mr. Ricardo's proposal of coloured buildings in the streets, would cause a great improvement in London. He did not think Mr. Statham need trouble about the harmonising, because if one passed through a beautiful garden of flowers it would be noticed that, although the gardener had not attempted to harmonise them they always did seem to harmonise. The beautiful design of a scheme of coloured architecture exhibited by Mr. Ricardo was most appropriate, and if work of such a kind could be carried out in London, it would greatly add to its attractiveness.

The Chairman, in proposing a hearty vote of thanks to Mr. Ricardo, referred to the subject of glaze, which, he said, rather lay outside both the artistic and structural sides of the question. Many architects who had consciences on the subject of lead poisoning might have felt that, by an extensive use of glazed tiles, they might be increasing the modern evil of lead poisoning. There was, however, another side to an architect's feelings on the subject, namely, that he not only had that difficulty before him, but he had the opportunity of doing a great deal of good in connection with the matter. Those who would take the trouble to make inquiries as to the nature, and as to the relative poisonous qualities of the various glazes in different kinds of tiles, would find that the mere fact of inquiring on the subject helped the battle which the Home Office was endeavouring to successfully carry through against careless manufacturers. He could not claim to have been innocent in the matter, nor to have never made use of tiles which were poisonous; but he had made some inquiries on the subject, and it was refreshing to find, not only how much was done by the more enlightened manufacturers in the way of getting rid of harmful glazes, and the substitution of those which were either harmless or less harmful, but also, that of recent years, some extremely successful experiments had been made in the use of altogether leadless glaze. Not long ago, inquirers would have been informed by any manufacturer of faïence that it was impossible to produce a leadless glaze which had the proper external appearance. That was no longer true. More than one manufacturer was now engaged in producing tiles which were absolutely leadless. It would have been interesting, if Mr. Ricardo could have found time, with his great knowledge of the manufacture of tiles, to state how far the ancients were able to produce tiles without the use of lead glaze.

The vote of thanks was carried unanimously.

Mr. RICARDO, in acknowledging the vote, expressed his indebtedness to the Board of Education, South Kensington, for the loan of the slides illustrating the paper.

SEVENTH ORDINARY MEETING.

Wednesday, January 22nd, 1902; ROBERT HENRY SCOTT, M.A., D.Sc., in the chair.

The following candidates were proposed for election as members of the Society:—

Braun, Henry Charles, 236, Pentonville-road, King's-cross, N.
Charles, Miss Bessie Ada, A.R.I.B.A., York-street-chambers, Bryanston-square, W.
Clarke, Caspar Stanley, 92, Cromwell-road, South Kensington, S.W.
Elstob, Charles, 6, Bradford-avenue, E.C.
Harris, William R. Alexander, Soho Mills, Wooburn, Wooburn-green, S.O., Bucks.
Reilly, Edward P., Cape Town and District Gas-light and Coke Company, Long-street, Cape Town, South Africa.
Tetley, Robert B., Lightwater Grange, Bagshot, Camberley.

The following members were balloted for, and duly elected members of the Society:—

Brydges, Edward Egerton Hanson, M.A., 11, Stone-buildings, Lincoln's-inn, W.C.
Calkin, Percival, Messrs. R. Rivière and Son, 33, Heddon-street, W.
Carey, Frederic William, Stratford-sub-Castle, Salisbury.
Ewing, William, 45, Renfield-street, Glasgow.
Foat, William, 20, High-street, Aylesbury, Buckinghamshire.
Gallini, John Baptist, 143, Great Suffolk-street, Southwark, S.E.
Gordon, Henry King, Cumberwood, Dorchester.
Harris, Lord, G.C.S.I., G.C.I.E., Belmont, Faversham, Kent.
Newson, Frederick Walter, care of Shewan Tomes and Co., Shanghai, China.
Peter, James, Mertinga Tea Estate, Munshi Bazaar P.O., South Sylhet, India.

The CHAIRMAN thought a few words of introduction to the paper might be interesting, particularly with regard to the organization of the arrangements of the International Balloon Association, with which he was connected. Mr. Glaisher was the first scientific man to make really high ascents, but his results lost much of their value, as he was not provided with a base station. At the date he made his ascents nobody realised that it was necessary to make observations on the ground to compare with those made at high altitudes. The first systematic international balloon ascents took their origin at the Paris Conference in 1896, of which he was secretary. Professor Hergesell, of Strasburg, proposed the establishment of a committee for the purpose of organising international observations, and this committee reported at considerable length to the next international meeting held at St. Petersburg in 1899. A very great number of balloon ascents were now being made in different countries. Unfortunately, up to the present, England had not taken much part, with the exception of the ascents made by Mr. Bacon. The most completely equipped establishment for all balloon work was that of Berlin. Balloons were sent up either manned or unmanned—*ballons sondes*. One of the latter had reached the height of 61,000 feet, more than double the height to which Mr. Glaisher went in his famous ascent. Among many interesting experiences with balloons was a very remarkable ascent made from Berlin on June 8th, 1900, when the aeronauts experienced a thunderstorm, but there was no thunderstorm at Berlin underneath. There was a thunderstorm over Westphalia to the westward, and in Pomerania to the eastward. The explanation of why the thunderstorm did not come near the ground at Berlin was that over the valley of the River Spree, the water being cooler than the air, there was a descending current of air which counteracted the normal ascending current of the squall. The consequence was that the thunderstorm was kept up, and jumped over the river. The barometer at Berlin at the time showed the ordinary little jumps characteristic of the passage of thunderstorms, but no thunder or lightning was noticed in the city. Another very interesting experiment was made on the 7th November, 1896. On a balloon ascending from Munich the aeronaut found he was over a series of rolls of cloud, which were enormous waves of air. To give an idea of what these waves of air were, he would state that a wave of water from twenty to thirty feet in length corresponded to a wave of air from twelve to eighteen miles in length, such was the difference of the density between the water and the air. On getting over the clouds it was found that there were chinks between them through which the whole landscape underneath could be seen. The actual distance between the different rolls of clouds was something like 600 yards. The experiment was extraordinarily interesting, the results fully agreeing with Prof. Helmholtz's theory with regard to the extent of atmospheric waves. Another very interesting experiment with *ballons sondes* was made in Austria during an anticyclone, in order to test its vertical depth. Two of the balloons ascended respectively to 8,900 and 10,000 feet, and descended within a short distance of the starting point. Another, which went up from Vienna, reached a height of 31,000 feet, got into the current of air above the anticyclone, and travelled a considerable distance. The thickness of the anticyclone was estimated to be 16,000 feet. It was very interesting to find that at the highest levels the variations of temperature were as extensive and sudden as on the earth below. The great advantages which these observations in balloons and kites offered were that they measured the free air, whereas mountain observations were always necessarily affected by the mechanical obstacle offered by the mountain to the motion of the air, because the air could not go through the mountain but must jump over it. Much had been done of late with kites. The first men to use kites were two Scotchmen, Dr. Wilson and Mr. T. Melvill, in Glasgow, in 1749. Mr. Douglas Archibald revived their use in 1884, chiefly for wind experiments; and at the present time there were very large establishments using them. The United States Weather Bureau had a great number of kite stations; also Mr. Rotch, at Blue Hill, Massachusetts; and M. Tesserenc de Bort, at Trappes, near Paris. Serious kite work was about to be instituted in Great Britain. The British Association, and the Royal Meteorological Society, had agreed to work together, and it was hoped that further funds would be raised for the prosecution of such research. Mr. W. H. Dines, the President of the Royal Meteorological Society, had kindly consented to conduct the work, the greatest difficulty being to find a locality where the trailing wire rope would do as little harm as possible.

The paper read was—

SCIENTIFIC OBSERVATIONS AT HIGH ALTITUDES.

By the Rev. J. M. Bacon.

Three years have elapsed since I had the honour of laying before this society such results as I had obtained in a series of balloon voyages undertaken for scientific research. In the interval, which I have been able largely to devote to aerial exploration, I have been fortunate in meeting with varied experiences never altogether barren of results, and not unfrequently leading to surprises. A succinct account of such experiences I will beg to read to-night, withholding nothing that has seemed of any importance, and frankly owning where difficulties or apparent inconsistencies have presented themselves.

I will state at once that my observations are not only varied, but cover a wide field, and this almost unavoidably so. I have long since given up the idea that an aeronaut can map out for himself a definite programme, feeling confident that he is going satisfactorily to carry it out in its entirety, and in the way he proposed to himself. There constantly arises in my mind the recollection of how in the first scientific aerial voyage worthy to be so-called, MM. Robinson and Sacharof found the balloon-car to be a sadly less convenient observatory than they anticipated. Its gyrations interfered with their deflecting magnet; its cramped quarters made other observations difficult; fog interfered at inopportune moments, and when they came to earth their instruments were broken.

Again, I am not likely to forget the advice which Professor Hergesell gave me when I first essayed scientific work in connection with balloons. It amounted to this:—"Don't attempt more than a very limited scheme of work in any ascent, or you will find that you will not get it done." Thus I have persuaded myself that the right attitude of the aeronaut who, with due equipment, starts on a voyage of exploration over English soil, is, while endeavouring to follow up some definite quest, to look out for all chance contingencies, to be prepared for surprises, and to neglect nothing of possible importance that may come his way.

I would like in the first place to discuss some noteworthy phenomena which have presented themselves with respect to upper air currents met with up to a height not exceeding two miles. The most skilled observer below has little knowledge of these. Such an observer was Mr. Glaisher, and he speaks with astonishment of the manner in which his balloon on one occasion crossed the Thames, then recrossed it, moving in an entirely opposite direction, till near the earth it again resumed its former course. I may, then, here cite two experiences of my own, different in character, though occurring on very similar days of heavy, overcast weather, when the sky was completely veiled. On the first occasion, starting from the Crystal Palace with only a light air, we entered mist at less than twice the height of the North Tower, at which point we determined our course as lying over the body of the Palace and on into the West. Then mounting rapidly we emerged in a new world at an altitude of about 4,000 ft., cut off from all view of earth by a tossing, sunlit cloud-floor. After an interval of two hours we descended, expecting to land in Hants or Berks, but landing there was none, for we found ourselves over the sea at the mouth of the Thames. We had been headed back by a fast upper current diametrically opposed to that on the ground.

Another occasion gave a record of continuous travel in the upper air probably without a parallel in English annals. The balloon had by mischance passed out of control, and for ten hours we were drifting at a height between 4,000 and 9,000 ft. above a universal cloud stratum, our start having been from Newbury, and our final descent taking place near the coast at Neath, Glam., where the wind was blowing half a gale. In this voyage we must have been either blown out to sea and brought home again, or else for the first sixty miles the wind at our high altitude can have been only blowing at a rate of less than eight miles an hour.

Differences in the drifts of upper currents and quick transitions from one drift to another are among some of the most noteworthy experiences of balloon voyages. It was on a still August afternoon that the intelligent following up of two diverse currents resulted in our steering our balloon, which I had equipped for signalling purposes with a "collapsing drum," across the entire stretch of Salisbury Plain, so that almost beyond my hopes I passed immediately over the military camps on the Plain, and exchanged signals with them. Not unfrequently it is possible to determine that the course of horizontal air currents, even up to a considerable height, are being influenced by the nature or conformation of the surface of the earth immediately beneath. I have, for example, met with numerous examples of such definite air streams following the windings of an estuary or river valley, and on one occasion at a height of a thousand feet over Kent, it was impossible to resist the conviction that we were for some miles strictly following a chalk ridge.

But in addition to such broader streams as may be traced without difficulty, it would seem that lesser rills or rivulets take devious and more uncertain courses through the upper air, at least, when this is not in rapid motion. In the voyage across Salisbury Plain, described above, while the balloon was being carried with the more sluggish current, a number of small parachutes were dropped out at frequent intervals and carefully watched. These would commonly attend the balloon for a little while, until getting into some minor air-stream, they would suddenly and rapidly diverge at such wide angles as to suggest, that crossing our actual course there were side paths, down which the smaller bodies became wafted.

Supporting this view of the motion of air streams, we have important evidence supplied by the wind gauges on the Forth Bridge. Here the maximum pressure measured on the large gauge of 300 square feet is commonly considerably less than that on the smaller gauges, suggesting that the latter must be due to "threads of air of limited area and high velocity."

Coming, as one must do, to temperature measurements, one becomes almost lost in a maze of results from which perhaps the most obvious and assured deduction is that there are regions often unsuspected, and not necessarily associated with visible cloud, where in ascending the decrease of temperature in day hours becomes arrested. This phenomenon was first noticed nearly a hundred years ago by Gay Lussac. The broad results obtained by Mr. Glaisher in his lofty climb, when there was no halting in the ascent, and, comparatively speaking, but little lateral motion, can best be shown graphically. On entering cloud at 5,700 ft., the temperature drops quickly; then remains practically stationary till, on emerging from cloud at 7,200, it rises. The usual law of decrease is then resumed till 17,600 is reached, from which altitude to 19,100 the temperature is sensibly stationary, after which, through a layer of 500 ft., a great drop is experienced, followed by a rise. This was virtually a confirmation of Welsh's results in 1852.

And the modern kite has told practically the same tale, revealing that currents of warmer air are constantly to be met with at varying altitudes, holding their courses above colder streams within all accessible limits, and in all conditions of weather. The most remarkable case of variation of temperature within a cloud is probably that experienced by Barral and Bixio, who recorded on penetrating cloud mass, a sudden fall of temperature from 15° to—39°. But the view assigning to the presence of cloud the cause of an anomalous pause or rise in the thermometer in balloon ascents would seem less correct than that which regards the meeting of the warm and cold currents as the cause of cloud. I think, however, that, as I have hinted, we should picture something more than broad air streams of varying temperatures holding determined sway aloft. If an air thermometer be taken up, specially designed for sensibility, and giving readings on a large scale; if this be slung in the clear some distance over the side of the car, and the whole attention be given simply to the play of the index, its behaviour, consisting of fitful sudden and rapid changes, will suggest that warmer currents are making their way in slender wandering rills, similar in fact to the lesser but distinct streamlets of air that were detected by the small parachutes over the level of Salisbury Plain.

I have spoken of restricted air streams, even at a considerable height, following a channel or river valley. On those occasions when I have been able to make satisfactory temperature readings of such currents, I have found them to be comparatively colder streams, suggesting justification for the somewhat quaint remark of Dr. Jeffries, in his memorable passage of the English Channel, only two years after the invention of the balloon, when he found a loss of buoyancy in crossing the sea, due, as he supposed, to the "power of attraction over the water."

Probably, intimately connected with the commingling of air streams just referred to, are the phenomena of haze. Let me give some typical examples which I have met with. I will indicate by photographs how a summer's afternoon, which allowed of a brilliant picture being taken in the grounds of the Crystal Palace at the time the balloon was about to be liberated, gave but the haziest image at no greater height than that of the neighbouring North Tower. Again, on another summer afternoon, when a fairly uniform altitude of about 1,500 feet was maintained, a haze which lay heavy over the suburbs, worked itself out completely as the open country was reached. Once again, a sail across the entire length of London from the south-west to north-east on an afternoon of last August showed quarters of the town which varied widely between the limits of great clearness and strongly-marked haze.

The sky meanwhile was not entirely clear, as may be seen from a cloud mass photographed drifting over the city. I have also a note made as the balloon hovered over the neighbourhood of Smithfield at an altitude of about 3,000 feet, to the effect that though the region of St. Paul's was hazy, as also that to the N. and E. in a less degree, yet in a narrow view to the S.E. there was a limitless stretch of town aud country of surpassing visibility.

Two considerations must mainly affect this manifestation of haze (1) actual particles in suspension in the lower air, capable of reflecting the illumination of the sky, (2) the commingling of such air streams as we have been considering. These must surely favour the formation of water dust in the atmosphere. We see evidence of this on the mountain side; again in those belts of mist lying across open country where opposing air currents meet and mingle; possibly, too, in the murky veil which gathers about a thunder cloud, and due presumably to the conflict of those contrary currents of widely differing temperature which have been held to be in part at least, the cause of such storms. Here I may mention as once having been entrapped aloft in the heart of a thunder storm, which met us across a clear sky, coming up rapidly against the wind that bore us, that as the storm broke around us, a pitiless cold down draught descended with hail and spread a thin blue curtain on all sides, which reached apparently to earth. On the other hand it is well established that total absence of haze permitting great visibility is generally a concomitant and forecast of special conditions of weather. With reference to isobars it is said to be noticeable on the east side of a wedge-shaped area. Having given examples of varying atmospheric states in and about London, I may here add very valuable testimony. Mr. W. Ellis has stated that "at Greenwich there is extensive view towards the Isle of Dogs and Blackwall. Very generally the prospect in this direction is obscured by haze, but on rare occasions there is remarkable distinctness, at which times, no matter how fine the weather may apparently be, rain has almost universally followed before the next morning. This has been noticed for very many years."

During night hours we have different atmospheric conditions aloft. The warmer air has then ascended. You find it, so far as my own experiences go, lying in strata at varying heights at least up to past midnight on a clear autumn night, while in a cloudy sky on a November night, as far advanced as 4.30 a.m., I have found the cloud layer, at an altitude of 2,000 ft. and more, many degrees warmer than the ground temperature, but on ascending to the upper margin of the cloud where it was vaporating into the clear sky intense cold was experienced. On the other hand, in the early morning hours of an August night under a clear sky, I have found the temperature up to a 1,000 feet sensibly the same as on the earth, until the sun began to rise, when at 1,500 feet the air very rapidly grew warmer, while below the level of the balloon a curtain of mist commenced forming over the surface of earth, doubtless there giving rise to the well-known chill of dawn. I will give photographs taken from a balloon showing what the camera will reveal as to the formation of mist up to the last available moment as night comes on, and again as light returns in early morning. Let me also show a series of pictures taken with long exposures from a considerable elevation during night hours in London. From these it will be seen that when the temperature of the lower air had become equalised, haze which had hung about the town at nightfall disappeared in a marked degree only to reassert itself again at dawn.

As to the presence of dust up to the altitude of a mile I have certain results to give. These results, however, only refer to what Tyndall defines as "floating matter of the air, whose particles are so coarse that their individual motions can be followed by the eye." I have used both Mr. Aitken's Dust Counter and also an apparatus for aspirating air through spirit carefully freed from floating particles, a method which answers well for comparative readings, and for balloon travel. I commenced with collecting samples of dust from air which had passed over a large tract of sea. For this purpose I chose the Scilly Isles, where never mind whence the wind might blow it was easy to find a rocky rampart, which caught the first blast off the ocean. Keeping these as standard results labelled according to the directions of those winds which had given them. I next compared them with results similarly obtained inland on open commons, in different quarters of London, and so on, finally transferring the experiments to the car of the balloon. As may be supposed the sample freest from matter in suspension was gathered in the Scilly Isles. It is likewise true that the most dust laden sample was also collected from the opposite cliff of the same island (St. Mary's), the explanation of which when discovered was instructive. The Island of St. Agnes lay a mile to windward, but its whole area was so small that I had regarded it as negligible. On visiting the island, however, I found it entirely carpeted with flowers grown for market and then in full bloom, whose pollen, borne on a fresh breeze, had not only loaded but stained the spirit in the test bottle. One of the clearest samples in the whole series was secured at the open end of the Aldersgate platform of the Metropolitan Railway, the explanation presumably being attributable to the passing trains attended with volumes of steam which emitted under the roof would entrap and cleanse out the dust. But another state of things was found aloft. On a still afternoon on May 1st, at 2,000 feet above Kingston, the air was found far more heavily charged with dust than that of the London streets the next day. So again at half a mile above the City in August last the dust, though somewhat less in quantity, was far more abundant than on the ground within the enclosure of Stamford-bridge in the forenoon of the following day.

One can hardly introduce the subject of the visibility or otherwise of the atmosphere without at the same time discussing the circumstances which determine its transparency to sound, and here we are faced by problems which have admitted of no easy solution. Extraordinary instances of the extinction at short range of powerful sounds specially designed, for warning signals are too numerous to be lightly passed over, and they are only matched in mystery by the equally numerous examples of sounds reappearing in strength at distances beyond what might be counted the limit of audibility. I can best show graphically some suggestive results obtained from a balloon, which I submit is in many important and obvious ways admirably adapted for a sound observatory.

But first I should discuss some preliminary trials which led up to the experiments I refer to. Guns or detonating fog warnings are necessarily among the commonest sound signals, and a unique opportunity for gauging the penetration of heavy gun firing was afforded by the measured salutes at sea, on the occasion of the late Queen's funeral. A rich harvest of reliable observations was obtained, which can be readily shown on a diagram, Desiring to gather further results under varying conditions I devised the following experiment. Standard four-ounce gun-cotton fog signals were fired at night singly from the ground, and also by rockets in the air. On the first occasion, the firing station being an elevated open heath, and the observors being planted at distances not exceeding six miles, it was noticed that the several detonations differed greatly, both in the initial report and in the after sound, as though in spite of the fact that the wind on the ground registered dead calm, there was a variable atmosphere capable of affecting results. I next on a night with a light air from the N.N.E. arranged for similar experiments from two elevated observing and firing stations, eighteen miles asunder, but within view of each other, these stations being respectively the Beacon Hills of Hants and Wilts, the former E.N.E. of the latter. The hour chosen was from 10 to 11 p.m., and though the exact moments of firing were prearranged, not the faintest distant report was detected at either station. It should be mentioned that the night was hazy.

In contrast with the negative results of this trial the next assumes importance. Through the press the co-operation of a large number of observers was enlisted. The night and hour (the same as before) were announced, but the moments of firing were unknown to anyone save the firer. The firing station was the Hants Beacon Hill, lying fairly midway between the two military camps at Bulford and Churn respectively, and about eighteen miles from each. On this night, which was without trace of haze, the wind blew strongly at right angles to the line joining these camps, and it was not surprising that few observations were received from distant stations, none at all from Churn, and one only as far as ten miles down the wind. The surprising fact, however, was that a staff-captain of Royal Artillery, who by direction of the commanding officer had stationed himself on the Wilts Beacon Hill, sent me in course of post a perfectly accurate and complete record of all the reports, not one of which he had missed.

I now varied the experiment by arranging to fire the same gun-cotton charges over London from a balloon, inviting observations through the Press as before. The trial was carried out on August 13 last, about 5.30 p.m., when, sailing over the heart of London, I fired two charges, one over Soho-square, at an altitude of 2,000 feet, the second four minutes later over Gray's-inn-road. We were travelling with a gentle breeze from the south-west, and at our altitude the air had grown more humid with an accession of moisture that declared itself in copious rain the next day.

Depicting on a map the localities whence observations were subsequently sent me, some curious deductions are at once obvious. (1) In the case of each report the number of observations recorded across the wind greatly exceed those recorded up or down the wind; (2) The longer sound ranges were chiefly in directions lying athwart the balloon's course; (3) Certain quarters neither particularly near nor particularly quiet would seem to have been accessible to the sound waves as by some special channel. One more fact should be noticed, namely, that from the open quiet parks, where foot passengers should have had more leisure to watch and listen, practically no observations at all were communicated. Possibly, however, sounds would be dissipated and therefore fainter in the open than within the environment of houses.

If from the last two detailed series of experiments it should appear that sounds are sometimes more audible across the wind than in its direction, it will be remembered that this is in accordance with a view expressed by Professor Stokes, who, regarding sound waves received directly as commonly reinforced by others reflected from the earth, pointed out that this reinforcement would be greatest in the direction in which the direct and reflected waves enclosed the smallest angle, and this he proceeds to show theoretically would be the direction at right-angles to the wind's course.

That there are, in certain conditions of atmosphere, at least what we may conceive to be aerial sound channels through which sounds are momentarily conveyed with abnormal intensity, has seemed to me abundantly proved in observations during balloon travel. The silence prevailing aloft is in favour of such observations; and moreover, in air flocculent with acoustic cloud, avenues of audibility would more readily shape themselves in upward directions, just as a bright reflection off the earth will sometimes find a chance path through cloud upwards to the aeronaut who is looking down on an apparently impervious barrier. Or, as in a London fog which obscures the opposite side of the street, and seems to blot out all the sky, a chance ray of light may be reflected off a lofty vane or finial down to an observer below, betraying that a momentary avenue had been formed leading up to the sunlight above. A remarkable instance of the casual passage of sound was afforded as day broke in one of the voyages already referred to. It was over the quiet pastures of Kent, with no sounds in the air save the first awakening of bird life. Suddenly, and for a brief second only, voices engaged in conversation whispered (I can use no other expression) in our ears, yet we were a quarter of a mile in the sky, and the speakers were not within view.

As this paper deals with various observations from high altitudes I would mention another made at the place and period just referred to.

The blast of a horn blown in the car was returned in a double echo. The first return from the earth immediately below was but a repetition of the blast,, while the second and feebler echo thrown back, presumably from sloping ground at some distance, was raised a major third in pitch. This tallies with experiments recorded in "Comptes Rendus" to the effect that of two notes of the same vibration the weaker gives an impression of higher pitch, and that a watch held at the ear sounds a third lower than when held at arm's length.

I would like to ask if aeronauts at especially high altitudes have noticed alteration in the *timbre* of the voice. This is very noticeable when air is compressed, and a striking example may be found in the workings of the electric railway now in progress under the Thames. In the tunnel shown in the photograph under ordinary conditions the voice sounds normally, but when air is compressed to something more than two atmospheres the voice is altered in quality, appearing strangely unnatural alike to the bystanders and to the speaker himself.

I have asked the above question seeking enlightenment, may I ask another. On several occasions I have been far aloft at cock-crow. The air has been calm and equable, and silence profound, and then in the darkness I have heard a challenge from a farm-yard below. It is answered from a score of others in close neighbourhood, and then further afield—further yet, much further, till from almost infinite distance the shrill penetrating calls still fall on the attentive ear. Well, the open country is to the eye of the aërial voyager without breach of continuity so far as neighbourhood of farmyards is concerned. From the fowl-roost point of view, all the land is a connected whole. When then at night any one single cock may crow, does a wave of crowing spread throughout all England? I can see no escape from this.

DISCUSSION.

Mr. J. Y. Buchanan, F.R.S., said he had been particularly struck with the reinforcement by the reader of the paper of a view he had held for some time, viz., that the cooling of the air was by streams, often very thin streams. A chemical friend of his likened them to striæ. It was only with the greatest difficulty that one could ascertain the temperature by thermometers, because all thermometers were very sluggish compared with the passage of such waves of hot air. It was therefore a matter of great interest to hear that the reader of the paper had found, up in the high levels of the atmosphere, the same sheets of hot air. The fact that in passing through a lower cloud, constancy of temperature was observed, was interesting, because on ordinary principles one would expect that to be so. The vapour of the air below gave a constancy of temperature, but when the balloon ascended there often immediately came a rapid descent. The subject merited further investigation. The up and down currents observed by Mr. Bacon were of very great importance in connection with aeronautics. Like many others present he had had ideas about flying, but he had been prevented from attempting to fly by knowledge that the result of these up and down currents would be that he would break his neck. In bad weather at sea we could see the waves, and navigate the ship accordingly, but in flying one was entirely at the mercy of the up and down currents of the air, which could not be seen. The up currents did not matter much; it was the down currents which were dangerous, as they would probably flatten the man who attempted to fly against the ground. That, in fact, happened to the only two men who had tried to fly. In reply to a question asked by a member, how it was that birds were not killed by those currents, Mr. Buchanan said that birds knew how to fly, having been taught to do so by degrees by their parents. Anyone who had studied birds flying, especially in a town, knew what a tremendous art there was in it. He once saw some pigeons sitting on a pavement in a narrow street, when the wind was blowing hard; and on rising to fly, one of the birds actually flew on its back for one or two seconds in order to weather the down currents.

Dr. H. R. Mill said the reader of the paper had brought home the fact that the upper atmosphere was not the region of monotonous uniformity they had sometimes been in the habit of thinking it was; and had pointed out very clearly that the Meteorological Society, the British Association, and other bodies who were about to attempt to again introduce kite flying into this country had a very large field of work, and had a very considerable prospect of adding to the amount of human knowledge if the observations could be carried on with sufficient uniformity and frequency in different conditions of climate.

Mr. W. Marriott said he had been particularly interested in the question of visibility and audibility. Some years ago, with the late Dr. Oliver Abercrombie, he went into the question of types of weather, and it was found that visibility and audibility were most frequent with a certain type of weather commonly called amongst meteorologists the ridge-shaped isobar, *i.e.*, the slight high pressure between two cyclonic systems. Numbers of charts could be easily inspected, and, if observations could be made at certain places where these conditions occurred, it would be readily seen that visibility and audibility were very much more pronounced on such occasions. With regard to audibility, some years ago he was at Ventnor, and a little after ten o'clock in the evening he heard a continual rumbling of firing of guns. He could not make out what the sound could be at that time of night, as it was most improbable guns were being fired at Portsmouth. He ascertained on the following day that guns had been fired at Cherbourg on account of the visit of the President of the French Republic. That was an analogous incident to the one mentioned by the reader of the paper in regard to the firing of guns at the late Queen's funeral. Some years ago, at his house in Norwood, he was in a direct line with the Clock Tower at Westminster, so that he could see the light when the Houses of Parliament were sitting, and hear Big Ben strike under certain conditions of weather. He then took regular meteorological observations at nine in the morning and nine in the evening. He was practically due south of Westminster, and it was when the wind was between W. and N. that Big Ben was heard most distinctly. He classified his observations of audibility into just audible, audible, and most distinctly audible, and had found that Big Ben was most frequently audible on Sunday, on account of the absence of traffic and noise. He thought that if the reader of the paper would collate his observations according to atmospheric conditions—whether it was anti-cyclonic or cyclonic or some other definition, and locate upon charts the precise observations, he would be able to find out some cause for the results he had obtained.

Mr. WALTER REID, in dealing with the air currents, said that one reason why the currents were so very frequent was on account of the amount of moisture in the air. Very frequently the outline of a sea-coast could be traced in the sky, especially in the spring. Clearly there must have been currents of air ascending laden with moisture. When the columns of air laden with moisture ascended, the moisture was condensed in a colder current, and the clouds that were formed could then be seen. Such currents could be obtained by a very simple experiment. If a solution of nitro cellulose or collodion was poured in a glass plate a very nice imitation of such currents would be obtained, caused by the rising of the ether, which produced a certain visible current. If a piece of cotton fabric or another piece of plate glass were placed above such a film to obstruct the rising of the current, the upward current was destroyed as well as the image produced upon the collodion. In dealing with the question of mists and the difficulty of photographing when the balloon was in a certain position, an ingenious invention was brought out some years ago by Daudet. Plate-glass was platinised with a very thin film of platinum. On looking at one side nothing could be seen except a bright mirror, while one could see through the reverse side like an ordinary pane of glass. If there were a number of particles of matter in the air with the light shining on them, and one tried to photograph them with the light behind, a very strong haze would be obtained; whereas if the photograph was taken sideways, with the illumination sideways upon the particles, a sharp photograph was obtained. If one desired to get a sharp photograph from a balloon he should not photograph with his back to the sun. but possible get into the shade of a cloud. With regard to the transmission of sounds, he thought there was a reason for the difference in the transplanting of the waves of sound. It would be thought that supposing 200 or 300 lbs. of nitro-glycerine were exploded down a bore hole 300 or 400 feet, that the greatest concussion would be felt at the top of the bore hole, or in the immediate vicinity; but that was not the case. The greatest concussion was felt at a considerable distance off, the distance being regulated by a code starting from the place where the detonation took place. There was a conical transmission of concussion which went at a varying angle according to the hardness of the rock in which the explosion took place. If a projectile were thrown against a thick piece of plate-glass the transmission of the force was not direct, but lateral at an angle; a conical piece of glass was broken out, not a straight piece. It was exactly the same with strong concussion in the atmosphere. A cone would be obtained, on the edges of which would be the strongest sound. It was impossible on the surface of the earth to get a true cone, because the earth obstructed it, but it was possible to get a cone from a balloon. When the reader of the paper obtained a sufficient number of observations from a balloon, it would be of immense value if he could trace a cone, the apex of which would be his balloon. It was very likely that he might be able in some cases, when there was a calm, to trace a cone of the transmission of sound.

The Rev. J. M. BACON, in reply, said the question of discovering the cone in the air was one he should very much like to pursue. He thought he had proved that ascending and decending currents were sometimes in very thin filaments. He gathered that from the fact that during a balloon ascent in the autumn he noticed thistledown wandering up in a trailing course, some ascending current wafting it up very rapidly, while at the same time the balloon apparently was not in the least affected. It must be very slender currents which entrapped such flying bodies.

The CHAIRMAN, in dealing with the question of upward currents, said that a few years ago a gentleman wrote up to the Royal Meteorological Society from Norwich stating that a number of flags were hung out on poles over the Cathedral as a decoration, and that he saw the whole of the flags pointing straight upwards into the air, indicating that there was a sufficiently strong upward current round the Cathedral at Norwich to carry up the flags.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Bacon for his paper.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 29.—"Technical Education as Applied to Paper Making." By CLAYTON BEADLE. CAPTAIN EDWARD PARTINGTON, J.P., will preside.

FEBRUARY 5.—"Jamaica." By HERBERT T. THOMAS. WILLIAM FREDERIC LAWRENCE, M.P., will preside.

FEBRUARY 12.—"Industrial Redistribution." By WILLIAM LEONARD MADGEN. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside

FEBRUARY 19.—"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A. GENERAL SIR GEORGE WENTWORTH A. HIGGINSON, K.C.B., will preside.

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E.

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS.

MARCH 12.—"The Utility of Alkaline Phosphatic Manures." By JOHN HUGHES, F.I.C. PROFESSOR HENRY A. ARMSTRONG, L.L.D., F.R.S. will preside

MARCH 19.—"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 6.—"The Coal Resources of India." By PROFESSOR WYNDHAM R. DUNSTAN, F.R.S. The Right Hon. LORD GEORGE HAMILTON, M.P., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 28.—"To the Victoria Nyanza by the Uganda Railway." By COMMANDER B. WHITEHOUSE, R.N. SIR HENRY M. STANLEY, G.C.B., will preside.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

FEBRUARY 4. 4.30 p.m.—"The History of the Rosary in all Countries." By the REV. HERBERT THURSTON, S.J. His Eminence CARDINAL VAUGHAN will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

SAMUEL RIDEAL, D.Sc., F.I.C., "The Purification and Sterilisation of Water." Four Lectures.

LECTURE III.—JANUARY 27.—*Mechanical and Thermal Purification.*—Mechanical filters—Use of coagulants—Softening—Precipitation by iron—Sterilising filters—Heat sterilisation.

LECTURE IV.—FEBRUARY 3.—*Chemical Purification.*—Ozone—Hydrogen peroxide—Chlorine—Chlorine peroxide and hypochlorites—Bromine—Manganates and permanganates—Acids—Sodium bisulphate—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "The Purification and Sterilisation of Water." (Lecture III.)

Imperial Institute, South Kensington, S.W., 8½ p.m. The Hon. Sir John A. Cockburn, "Federal Fulfilment."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on papers by Messrs. A. Dudley Clarke and G. S. Mathews, "The Final Report of the Local Taxation Commission."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn Hall, Holborn, E.C., 5½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. W. Mott, "The Development of the Human Brain as an Organ of Mind."

TUESDAY, JAN. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C. 4½ p.m. (Colonial Section.) Commander B. Whitehouse, R.N., "To the Victoria Nyanza, by the Uganda Railway."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. Macfadyen, "The Cell; its Means of Offence and Defence." (Lecture III.) Immunity.

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. Joseph Davis, "The Sewerage Systems of Sydney, N.S.W., and its Suburbs." 2. Mr. William Naylor, "The Bacterial Treatment of Trades Waste."

Photographic, 66, Russell-square, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting. Address by the President, "What the United States are doing for Anthropology."

East India Association, 3, Victoria-street, S.W., 4 p.m. Mr. Alexander Rogers, "The Spread of the Municipal Idea in India."

WEDNESDAY, JAN. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Clayton Beadle, "Technical Education as appled to Paper Making."

Archæological Association, 32, Sackville-street, W., 8 p.m.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

THURSDAY, JAN. 30...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. G. J. Burch, "Colour Vision."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. S. Murray, "Recent Excavations at Delphi, and in the Greek Islands." (Lecture III.)

FRIDAY, JAN. 31...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. A. Crum-Brown, "The Ions of Electrolysis."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Messrs. J. C. Collett and W. H. C. Clay, "The Quay-Walls of Keysham Harbour."

SATURDAY, FEB. 1...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. H. Hadow, "Landmarks in the History of Opera." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, February 3, 8 p.m. (Cantor Lectures.) Samuel Rideal, D.Sc., F.I.C., "The Purification and Sterilisation of Water." (Lecture IV.)

Tuesday, February 4, 4.30 p.m. (Applied Art Section.) Rev. Herbert Thurston, S.J., "The History of the Rosary in all Countries."

Wednesday, February 5, 8 p.m. (Ordinary Meeting.) Herbert T. Thomas, "Jamaica."

Thursday, February 6, 4.30 p.m. (Indian Section.) Prof. Wyndham R. Dunstan, "The Coal Resources of India."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 27th inst., Dr. Rideal, F.I.C., delivered the third lecture of his course on "The Purification and Sterilisation of Water."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday, January 28, 1902; Sir Henry M. Stanley, G.C.B., in the chair.

The paper read was "To the Victoria Nyanza by the Uganda Railway," by Commander B. Whitehouse, R.N.

The paper and report of the discussion will be published in a future number of the *Journal.*

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

The Council of the Society of Arts have determined to add to the existing system of examinations, *vivâ voce* examinations in modern languages. At present it is proposed to hold such examinations in French, German, and Spanish; other languages will be added as soon as a demand arises. It is the hope of the Council, that eventually it may be possible to require all candidates in modern languages to pass a *viva voce* examination, as well as a written one, and to restrict the issue of certificates to such candidates.

The examinations will be held at any date, at any of the Society's examination centres, where the local Committee will undertake to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate, for not less than 24 candidates. Unless as many as 50 candidates are entered, the local Committee will also be required to pay the examiner's travelling expenses, including first-class railway fare from London, to the place where the examination is held. The Committee will also be required to defray all the local expenses, and to provide a convenient room for the examination, together with a suitable waiting-room for the candidates. To cover such expenses an additional fee may be charged. Such arrangements may be made as may be convenient for the simultaneous examination of all or part of the candidates in Dictation. Except as regards the Dictation part of the examination, no person, except the examiner and the candidate under examination, should be allowed in the examination room while the examination is going on.

The examination will include Dictation, Reading, and Conversation. Candidates will be expected to satisfy the examiner in all these branches. Candidates who do so will receive a certificate of proficiency in Colloquial French, German, or Spanish, if, in the opinion of the examiner, they can express themselves fluently in the language selected; minor grammatical errors will not prevent success. The candidate's grammatical knowledge will be tested, as hitherto, by the written examinations of the Society in modern languages.

The examination might be held for 2½ hours in the morning, 2 hours in the afternoon, and 2 hours in the evening. It is calculated that an examiner will be able to examine eight candidates per hour, or about 50 per diem. But the time and duration of the examination can be arranged to suit the convenience of the local Committee, on the understanding that it does not last for more than 6½ hours in all, with suitable intervals.

In order to secure uniformity of standard, it is intended, at all events for the present, that all the examinations shall be conducted by the same examiner.

The Committees of different local centres may, of course, combine together for the purpose of holding a joint examination in their locality.

Secretaries of local Committees desiring to hold *vivâ voce* examinations should communicate with the Secretary of the Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 23, 1902; SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., in the chair.

The paper read was—

BENGAL—THE LAND AND ITS PEOPLE.

By FRANCIS HENRY SKRINE.

In attempting to compress the history of the province in which my best years have been spent within the limits of an hour's discourse, I feel a difficulty akin to that which perplexed our greatest dramatist when he was called upon to display the panorama of Henry V.'s conquests on a stage which would not contain "the very helms that did affright the air at Agincourt." A bird's-eye view of a tract nearly twice as large and populous as the United Kingdom must necessarily be superficial, but it shall not be burdened with dry and dubious statistics.

The plains of Bengal are hemmed in on the north by the mountain wall of the Himalayas, which serves as a surrounding sea, isolating India from external influences, and permitting the unchecked growth of a civilization as complex as our own. Southwards lies the ocean, and the province is fringed on the west by a spur of India's backbone, the Vindhyan range. Dense masses of vapour from the sea are yearly driven inwards by the south-west monsoon, to beat against the Himalayan slopes, and dissolve in torrents of tropical intensity. These give birth to the Ganges, the Brahmaputra, and a score of rivers less known to fame which emerge from their mountain fastnesses with irresistible force, and then, checked by the level of the plains, spread out into a maze of ramifications. They annually bring down millions of tons of silt, which renews the vigour of the soil, and, when their course is run, they enter into a conflict with the ocean tides and currents. In this manner Bengal was slowly won from salt water: thus is its boundary daily extended. It was but natural that forces so vast and so beneficent should appeal to the imagination of a people at the early stage of its growth; that the Ganges should be adored as a deity, and her mighty brother should be fabled to descend from the loins of the Creator himself.

In prehistoric times, the soil thus gained by a struggle between river and ocean was inhabited by dark-skinned aborigines, who lived by fishing and the chase, and passed through a stone, a bronze, and an iron age. About a thousand years before the dawn of the Christian era, a wave of invasion burst on them through the passes of the North West. The newcomers were blood relations of our own ancestors—a fair-skinned race, proud, warlike and highly organized. They drove the inferior human growth back to its mountain retreats, and to the sea fringe of its habitable area. Thus at a very early period the Delta was peopled in its central portion by Aryans, whose descendants still retain traces of their high lineage, while elsewhere the old strain has mingled more largely with the blood of autochthonous tribes.

The invaders were originally nomads, subsisting on their flocks and herds, but they slowly crystallized into a settled population, forming village communities, which, despite centuries of cruel neglect, are to this day self-contained and self-governing. They brought with them a highly developed caste system, which is not without its analogies in Europe. Their religion was polytheism—a worship of the powers of nature, which once bore a remarkable affinity with the graceful beliefs of Hellas, but was soon overcoated with a dense growth of wild and grotesque legend, evolved by an all-powerful priesthood. At one time purer ideals bade fair to prevail. Buddhism took its rise in Western Bengal, where the royal sage was born, and where he taught his undying lessons of self-devotion, self-sacrifice and universal love. But these doctrines clashed with the selfish and mundane caste-organisation of the Aryans, and from the resulting struggle the creed which was based on lower ideals emerged triumphant. Hinduism had no place for the subject races, who were treated as Helots, and could never penetrate the pale of caste. On such the teachings of Mohammad shone as a beacon light. They were brought by successive waves of invasion from Afghanistan and Central Asia, prompted by the fierce and proselytizing spirit of Islam. On the establishment of Mughal power in Upper India, Bengal fell an easy prey to the invading hosts, for the warlike spirit of the Aryans was sapped by the softness of the climate and the ease with which a living could be compassed. For years the province was the granary and treasure-house of the Empire, affording the sinews of the wars of aggression, which placed the entire peninsula under the sway of Babar's dynasty. Its Subadars, or Viceroys, fixed their capital at Dacca, a city conveniently placed for levying transit duties and repelling the attacks of the Burmese river pirates. As the central power grew feebler they were emboldened to throw off the yoke of Delhi and to assume all the attributes of royalty. With the vast resources of Bengal at their back, and their hordes of Arab and Pathan mercenaries, the Subadars would have shifted the seat of empire to the easternmost province but for the advent of a stronger force which was destined to remodel the map of India.

The 17th century witnessed its humble beginnings. The merchant-seamen of England embarked on a struggle with their Portuguese and Dutch rivals for the rich Eastern trade. In 1635 our young East India Company established a factory on the coast of Orissa, and five years later they extended their operations to Hughli, a point on the river of that name above the site of Calcutta. At the close of the Commonwealth era a commercial agency was founded at Kasimbazar, on a loop formed by one of the branches of the lower Ganges, and the third quarter of the 17th century found the British carrying on their operations at most of the points of vantage on the riverine system. They were timid traders, willing to pay blackmail to the Mughal Viceroys, in return for permission to barter English cutlery, woollens, arms and toys for the indigo, sugar, fine cottons and silks of which Bengal possessed a monopoly. In 1681 these settlements were relieved from their subservience to Madras; the wealth of the Bengal establishments grew rapidly, and with it the domineering character of our race made itself felt. In 1688, the year of the Glorious Revolution, the native Viceroy determined to rid himself of these pestilent adventurers, and so menacing was his force, that the Company's servants abandoned Bengal, and sailed down the inhospitable river to Balasor. But this exodus was not to the taste of the Delhi Court, whose luxury was fostered by the gewgaws brought by the despised merchants. They were recalled by Imperial decree, and granted a site for their factory at Calcutta, protected on the West by the swift Hugli, and Eastwards by a trackless swamp still known as the Salt Lakes.

The new settlement speedily became a rallying place for the industrious traders and artisans who groaned under Moslem oppression, and a teeming native population grew up round old Fort William. The British interlopers waxed in wealth; a tawdry imitation of Oriental pomp replaced the semi-monastic simplicity of the factory, and gross luxury conspired with a pestilential climate to render Calcutta a charnel-house.

In the meanwhile momentous changes were taking place in the native government. In 1707 the capital was transferred by an able Viceroy from Dacca to Murshidabad, which was close to the British emporium of Kasimbazar, and centrally situated for administration and trade. The new city soon grew to dimensions far exceeding those of contemporary London. Its environs were covered with the pleasaunces of the nobles of the Viceregal Court, and legends still linger of the magnificence attending the religious festivals, and the annual gathering of the zemindars, known as the Punya. The province at large suffered even as France did when its brains and wealth were concentrated at Versailles. The land revenue was farmed to the highest bidder among courtly sycophants; roads there were none, and but for the tenacity of the village system, Bengal must have fallen a prey to anarchy. The tottering fabric of Mughal rule was well nigh overthrown when hordes of Maratha horsemen poured into the Delta from the south-west, overrunning Orissa, and levying a tax of a fourth of the land's produce. These foes were more dreaded than Danes or Normans by our Saxon ancestors; and to this day the "Borgis" are used as a bugbear by many a Bengali mother.

Ali Vardi Khan, who succeeded to power in 1740, was sorely harassed throughout his reign by these organised robbers, and the terror which they inspired prompted him to treat the English merchants with a semblance of courtesy. No such motives of policy restrained the evil passions of his grandson, Sirajuddaula, who came to the throne in 1756. He was a rash and ill-bred youth of eighteen, whose pride revolted at the growing riches and influence of the intruders. The story of his capture of Calcutta has been told too often to need recounting here. Its crowning horror, the Black Hole, burnt itself deeply into the imagination of our ancestors, who forgot that infamies far greater, because they were longer drawn out, were enacted in many a British jail. Professor Seeley says truly that the history of prison management began with barbarous insensibility, to pass through a period of strict law and justice, and end with one where mercy and sympathy hold sway. Nor need I enlarge on the recapture of Calcutta by Admiral Watson, a spirit as gallant and gentle as Lord Collingwood's, and by Clive, whose meteor career proves that military genius is born, not acquired, but that opportunity, in other words good luck, is needed to give it scope. Now the distracted province was dragged into European complications. Pitt, the elder, plunged into a struggle with France, which led to the conquest of Canada, and indirectly to that of India. Stout-hearted Admiral Watson sailed up the Hughli, and captured Chandranagore, a French settlement, which was then a formidable rival of Calcutta. The young Viceroy, indignant at the insult offered to his authority, again let loose the dogs of war against the insolent islanders. Clive adopted the tactics usual in the East. He ferreted out a claimant to the throne of Bengal in the person of Mir Jaffir, a poor creature, who afterwards went by the sobriquet of "Clive's Donkey," and mustering his slender forces, marched against Murshidabad. Plassey, where he encountered the Musalman hosts, has been well nigh swallowed up by the branch of the Ganges on which it stood. It was a hunting retreat of the Viceroy, with a pleasure-house and a grove of splendid mango trees, which the British occupied and protected with entrenchments. At noon on that eventful 23rd June, 1757, Clive saw his opportunity. The enemy, after a desultory cannonade, proceeded to cook their midday meal, and while thus engaged, they were fiercely attacked by the British. Confusion spread among the vast multitude of horse, foot and elephants, which fled precipitately towards the capital. Plassey, which taught us that the Mughal giant had feet of clay, and decided the fate of India, was not a battle in the proper sense of the word. It was, like Rosbach, a rout in which there was very little severe fighting. The victorious forces entered Murshidabad on the heels of the dispirited foe, and the puppet who was set on the throne showed his gratitude by dividing the hoarded wealth of Ali Vardi Khan among the British leaders. Clive's share was not limited to cash and jewellery; he obtained for his masters the proprietary right in the Twenty Four Parganas, or revenue districts surrounding Calcutta, but constituted himself the Company's feudal superior, to his great pecuniary benefit. After his return to England, gorged with plunder, the Calcutta Council threw off all semblance of moderation. Eager to pocket the large bribes which followed the change of rulers, they dethroned Mir Jaffir, and replaced him by Mir Kasim. The new Viceroy showed a degree of vigour which is rarely seen in a Mohammedan Prince. He set his house in order, took sagacious methods of reforming the revenue administration, and equipped an army of stalwart mercenaries. But in his efforts to govern wisely he was sorely hampered by the British Council, who claimed exemption for their goods from the internal transit duties which were one of the pillars of the Mughal exchequer. Nay, they sold their passes (called *dastaks*, from the Persian word for signature) to the highest bidder, and the Viceroy's officers found themselves thwarted at every turn. At length, driven to desperation, Mir Kasim grappled with the incubus. The English officials at outlying stations were ruthlessly massacred, but the Mughal levies were again no match for the disciplined forces of the West. Mir Kasim was defeated and dethroned, and with him native government fell to rise no more. Now Clive hurried out from England to reap profit for his country and himself from these momentous transactions. He obtained from the Emperor at Delhi the right to collect the land revenue of Bengal, called the *Diwani*, as opposed to the *Nizamat*, or criminal jurisdiction. The Viceroy, or Nawab Nazim, became a *cochon à l'engrais*, as Napoleon phrases it, at £600,000 a year, which has been whittled down to a pittance of £15,000. Having thus secured the sinews of war for his honourable masters, Clive set himself to the task of purifying the administration. Hitherto the salaries drawn by the Company's officers had been nominal,* and they were permitted to enrich themselves by private trade. Clive's efforts at reform raised a white mutiny, and on his final retirement to England he was hunted from pillar to post by infuriated monopolists, with whose profits he had interfered. His measures did not long survive their framer's departure, and the Calcutta Council again plunged into a course of oppression. Anticipating the trend of commercial mechanism by more than a century they formed "corners" in all the necessaries and humble luxuries of the peasantry, such as salt, opium, tobacco, and betel. Nay, there is too much reason to believe that the fearful famine of 1770, which swept away a third of the population of Bengal, was intensified by the machinations of these hucksters in high places. Well might Lord Erskine declaim against the "knavery and strength of civilization," for there can be no doubt that British rule brought more curses than blessings on India during the earlier years of its currency.

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* In 1773, the Chief of Kasimbazar, and Resident at the Nawab Nazim's Court, drew Rs. 1,704 per member, including allowances for servants and table. Under him were four "Merchants," headed by Mr. John Shore, afterwards Lord Teignmouth, whose salary was Rs. 250. The eight "Writers" attached to the factory had pittances of Rs. 30 per member. The Chaplain's pay was Rs. 50.

While Bengal was still in the throes of famine, Warren Hastings succeeded to supreme command. He had come to India as a "writer," or apprentice, at seventeen, but unlike his fellow civilians, he did not neglect the culture which he had gained at Westminster School. Amiable and warm-hearted, tactful, patient and experienced, he possessed nearly every gift which made for success in a position of unparalleled difficulty. His defects arose from the orientalising influences which had surrounded him from early youth, and profoundly modified his sympathetic and receptive nature. In 1756, when the tyrant Sirajuddaula was endeavouring to drive the English from Bengal, Hastings was attached to the Kasimbazar Council, and he escaped the slaughter in which his countrymen were involved by taking refuge in the oven of a poor confectioner named Kanta Mudi, who had a shop just outside the Residency gates. He was thus concealed until the fury of his pursuers was spent, and when he fell into the Subadar's hands he was soon released on the security of the French and Dutch Factors at Kasimbazar. Kanta Mudi continued to vend his unwholesome sweetmeats, till one day he was summoned to Calcutta by a red-coated minion of the Governor. He accompanied the messenger in fear and trembling. What was his surprise on arriving at Government House to be inducted to a vast Council Chamber, where, on a dais surrounded with all the pomp of an Eastern Court, stood the very sahib whom fifteen years before he had rescued from death! He flung himself on the ground before the great man, but was tenderly raised up and introduced to the Council as Hastings's preserver. Kanta Babu became diwan or factotum to the Governor-General, was his "man of straw" in many a dubious transaction, and figured largely in the annals of the 18th century. He amassed a vast territorial fortune by none too honest means, and was the ancestor of the husband of the late Maharani Surnamoyi of Kasimbazar, a Bengali Baroness Burdett-Coutts, from whom I learned this curious episode. Some other anecdotes illustrating the magnanimity of the great Proconsul may be gleaned from the rambling memoirs of Miss Hawkins, the daughter of Dr. Johnson's executor and biographer. A young relative of Hastings in the Bengal army was told off to lead the forlorn hope at the storming of Gwalior. On the eve of the desperate attempt he wrote his will on a drumhead. It was to the effect that he had left a wife and two children in Calcutta and naught else but a load of debt. He appointed the Governor-General his executor, and enjoined him to discharge his obligations, and provide for his little ones and their mother. The young soldier fell at the deadly breach, and Hastings cheerfully accepted the trust, and did all that was required. On another occasion he lent £10,000 to a man who afterwards joined the ranks of his bitter foes. When his private secretary advised him to sue the scoundrel as the only means of recovering his money, Hastings replied, after an inward struggle, "I cannot do it; he is my enemy. I cannot do it." His first step on assuming the functions of Governor-General was to place the finances in a sound condition. He "stood forth as Diwan,"—in other words, he performed the duty of gathering in the revenues from land, and for this purpose appointed British officials in every district, under the familiar designation of "Collector." Thus Bengal became again the treasury of the Empire, and its marvellous recuperative powers soon obliterated the traces of famine. This and many other administrative reforms were carried through in the teeth of a virulent and unscrupulous opposition fomented by his colleagues in Council, and his legitimate authority was not regained till that truly Oriental *coup d'état*, the execution of Nuncomar, convinced Bengal that Hastings's side was the strongest. After thirteen years of eventful rule, this great Proconsul was succeeded by the Marquis Cornwallis, a high-minded Englishman, of the type produced only by that much-abused 18th century, who, building on Hastings's foundations with larger means, gave the laws and the mechanism of Government the shape which they still display. He founded the Civil Service, a *corps d'élite* with traditions of efficiency and public spirit which have seldom been belied. He assumed the task of administering criminal justice, and established a Supreme Court at Calcutta, which thus became the seat of Empire. But Cornwallis's greatest measure of reform was that of the Land Revenue. In all Mohammadan States, the soil is theoretically the property of the Sovereign, who is at liberty to reward military service and pacify grasping priests by alienating portions of his vast estates, and to maintain his royal pomp from the rental derived from the remainder. Thus under native rule, the lands of Bengal were farmed out to hangers-on at the viceregal court, who were styled zemindars, or landholders. The annual demand, under Akbar's vigorous sway, was ascertained by actual measurement, but when the central authority weakened, the quotum of the State was roughly arrived at by biddings among the postulants for farms. These, in their turn, imitated their master, the Subadar, by making their leases hereditary in their families. But ownership, in the British sense of the word, was incomprehensible to the native mind. The struggle was not for land but ryots, literally "subjects," whose labour gave worth to that which was *per se* as valueless as air or water. When a zemindar fell into arrears he was brought to reason by a military force. The smaller fry, under Ali Vardi Khan, were coerced by imprisonment in a dungeon knee-deep in filth, which the last of the Mughal Viceroys humorously styled *Bihisht* (paradise). Others were convinced of the error of their ways by being forced to don capacious trousers full of wild cats. The land revenue, thus gathered in, filtered through a succession of corrupt native officials, and that which reached the exchequer was a mere fraction of the amount extorted from the unhappy ryots. Nay, it varied directly with the seasons, and the East India Company's budget was constantly deranged by vast deficits in the collections. This uncertainty was not to be endured, and Lord Cornwallis went out to India with a mandate from the Court of Directors to fix the Government demand from lands in perpetuity. His own instinct as a territorial magnate led him to follow the policy thus inculcated with ardour. 1789, the first year of the French Revolution, saw the beginnings of one as momentous in the internal economy of Bengal. An assessment was made of the yield of each estate, not based as it should have been on a cadastral survey, but on the actual demand in previous years. Now, apart from defects inseparable from the rough and ready methods which were alone available, Lord Cornwallis and his right-hand man, Sir John Shore, had to deal with ignorance in the over-tasked collectors, and wholesale corruption in the zemindars and native subordinates. And, while the central districts were fairly well cultivated and, therefore, fully taxed, those to the north and east were still covered with jungle, and escaped with a pepper corn assessment. For good or for evil the estimates arrived at in 1789 were declared in 1793 to represent the permanent demand by way of land revenue. The farmers became copyholders, and the punctual payment of the quotum of the State was assured by a cast-iron sale-law, which provided that defaulters' estates should be put up to public auction in case the instalments of Government rent were not paid on due date. The result was that most of the new-fangled proprietors were expropriated within ten years. With few exceptions the present race of zemindars are or represent "innocent holders for value," as our lawyers say; and they cannot be ousted without receiving compensation which would cripple the Indian Exchequer. But the greatest injustice of the Permanent Settlement was the absence of any effectual mechanism for assuring to the tillers of the soil the same fixity of tenure which was conceded to the zemindars. Lord Cornwallis indeed, gave platonic utterance to a hope that his *protégés* would devote themselves to improving their property. But the rights of the ryots, which were far more ancient and more firmly established than those enjoyed by the farmers, were ignored; and more than ninety years were destined to elapse ere effectual attempts were made to enforce them. The Marquis's optimism was soon belied by events. A device was introduced in the great estates of the Maharaja of Burdwan by which the zemindars alienated parcels of their property for ever, receiving a rental in excess of the Government demand. These miniature permanent settlements received the sanction of law, the zemindar sank to the status of annuitant on the land, and a hierarchy of middlemen was gradually inserted between the State and the unhappy cultivator. If a century has converted a wilderness into a garden, the agency at work has been the British peace, the advent of foreign capital, roads and railways, and the introduction of new staples. The zemindar's increment has been wholly unearned by him.

During the next sixty years India was under the sway of a long line of able Governor-Generals, who were also *ex-officio* Governors of Bengal. But they were absorbed in wars of conquest and aggression, for which their immediate charge furnished the sinews, and it received a very scanty share of their attention. It is proverbially darkest under the lantern, and during the first half of last century the Lower Provinces were the least progressive of our Indian satrapies. The primary function of a civilised Government is to provide good roads and an efficient police. The only communications kept in decent repair were those which served strategic purposes; and but for the slow growth of population, which did not tend to outstrip the means of subsistence until about 1840, there must have been a constant recurrence of famines. As to the police, it is sufficient to say that dacoities, or gang robberies, were rife in the suburbs of Calcutta, and that a reign of terror prevailed in remoter districts. All attempts made to spread Christianity were long discouraged. At the end of the 18th century a band of devoted men who came nearer to Apostolic ideals than any preachers since the days of St. Paul, settled under the Danish flag at Serampur, but it was not till 1813 that a renewal of the Company's Charter enabled their friends at home to secure a bare toleration for missionaries. One wholesome reform was due to their efforts to awaken the conscience of England. Among the Scythian rites introduced by the invaders of India was the immolation of the widow on the funeral-pyre of her lord. *Sati*, as it was called, had no authority in the sacred writings of the Hindus, and, strange to say, it was practised with greatest assiduity in Bengal, where the warrior spirit was well nigh extinct. To this day the landscape in the Eastern districts is dotted with tall spires, recalling the village churches of Old England to the exile, which mark the site of one of these inhuman sacrifices. Nor did the evil end with the eight or nine hundred lives thus taken every year. Millions of the victims' sisters, whose courage was not equal to self-immolation, were pursued through life by the tormentings of conscience and the reproaches of their relatives. The abolition of *Sati* is one of the few bright passages in a story of neglect and incompetence. Another innovation destined to have results even more momentous was carried into effect a few years later. The great movement for educating the people at home spread to India, and those charged with giving effect to it were ranged in two hostile camps. The first consisted of Oriental scholars, who urged the adoption of Arabic and Persian, and of the noble vernacular, true daughter of the Sanskrit, as vehicles for public instruction. The second was headed by the future Lord Macaulay, whose rhetoric convinced the Government that a knowledge of English literature should be the shibboleth of admission to Government service and the legal profession. Thus in a few years Bengal was dotted with colleges and schools imparting a purely literary training through an English medium. Hither flocked the youth of the upper and middle classes, for there are no sacrifices which a Bengali father will not make to give his son the best education. Their receptivity and acuteness enabled them to master the English text-books with marvellous rapidity; and the finished product has given a too abundant supply of lawyers and clerks. But young Bengal has made the fatal mistake of regarding education rather as an end to compass definite worldly ambition, than as enabling the inborn mental powers to serve the purposes of self-culture and the good of others. He gorges himself with English lore in order to gain entrance to some Government office, to add to the crowd of briefless ones, or to obtain a degree, which has a definite value in the matrimonial market. The hosts which have drawn blanks in the lottery of life make their voices heard in the Press, and it is needless to add that they are not given to the Government, whom they regard as a cruel stepmother. Another glaring defect in our educational system is its neglect of technical training. There are vast districts which can furnish only the simplest articles of domestic use; and the Bengali's ideas of art might make the late Sir E. Burne-Jones turn in his grave. Thus, although the Indian's character is eminently suited to the factory system, and his quickness and delicacy of touch might easily make him an artist, he is still wedded to an overtaxed soil. No sustained effort has been made to utilise the vast reserves of human labour in promoting manufactures. What was done in that direction in the earlier days of our rule was accomplished in the teeth of official discouragement, for it was the settled policy of the oligarchy of Leadenhall-street to repress "interlopers," as those were called who did not then belong to our civil and military establishments. Under its regime, the vivifying power of English capital and the eager energies of our race never received fair play.

The immediate effect of the spread of English education was to sap the religion of the Hindu youth who crowded the class-rooms. They copied John Bull in his vices without assimilating his virtues. Things were otherwise with the Mohammadan proletariat during the dark days of the 19th century. The semi-Hinduized millions were stirred by the preachings of Wahabi missionaries, propagators of a Puritan movement which aimed at restoring the pristine fervour and purity of Islam, and a great revival set in which led to organised revolt against our authority. This movement was quieted, but the spirit which animated it still survives. The Indian Mutiny owed its being and much of its vigour to religious influences, for Oriental populations, however sluggish they may seem in ordinary times, are subject to waves of wild agitation. These arise from the most trivial causes, and act powerfully on the credulity and superstition of the masses.

The fullest advantage was taken of these idiosyncrasies by the wire-pullers who engineered the rebellion of 1857. It began in the overgrown native army, which was not slow to perceive the rottenness of our military system. Bengal, including the Upper Provinces, had a European garrison consisting of a regiment of cavalry and four weak infantry battalions. European artillery there was none, and with the exception of Fort William, the arsenals were held by native regiments. The latter were recruited from a few superior castes amenable to Hindu plottings. They were drained of their more efficient officers by the policy of the Company, which insisted on manning the political, executive, and Public Works Departments by military officers. The generals were worn-out veterans with at least half a century's service, and inspections were matters of form. My father-in-law, who joined the Bengal Artillery a few years before the cataclysm, tells me that the only horses shod in his battery were those which drew the commanding officer's four-in-hand. The fatuity revealed by a study of the Army-list for 1857 is so amazing that one is inclined to wonder that the catastrophe was delayed so long. The bolt that fell from the blue was forged in Bengal, for the mutiny began at Barrackpur, and spread like wildfire over the province. At Dacca, Chittagong and Berhampur, the troops threw off their allegiance, looted the Government treasuries and scattered, mostly to perish in the trackless jungles of the North Eastern frontier. In Jessor, the plotted murder of the Europeans by the military police was foiled by the vigilance of their intended victims, one of whom was Mr. W. S. Seton-Karr. Calcutta was seized with a panic which contrasted strangely with the fortitude shown at stations where the danger was far more real. On a certain "Black Monday" many Europeans left their houses to the mercy of the criminal classes, and crowded into Fort William on a false alarm that the sepoys at Barrackpur were marching on the capital. In Behar, the rising was more general. It is inhabited by warlike races, and is a recruiting ground for the native army, but a little tact and courage on the part of our civil and military authorities might have saved these wealthy districts from anarchy. The crass stupidity of the Calcutta Board of Revenue drove Kuar Singh of Jagdispur, an old Rajput Chieftain, into the rebel ranks, who kept South Behar in a ferment for many months after peace had been restored in the Upper Provinces. The one bright spot in a record of folly and mismanagement was the defence of a small house at Arrah by a few British officials, which moved the heart of England as profoundly as the resistance of the Mafeking garrison stirred it in our own day.

The Mutiny, in spite of the awful suffering it entailed and the lasting injury it inflicted on our prestige, was a blessing in disguise. It revealed the weak spots in the imposing fabric of our Eastern Empire, and brought home to the people of these islands a sense of the great responsibilities which Providence had laid upon them. The Queen's Proclamation on assuming the sovereignty of India shows a degree of statesmanship far higher than is seen in the other measures adopted to unite England more closely with her great dependency. It is regarded by the educated classes as their Magna Charta, and has inspired them with a sense of citizenship which, if rightly directed, may yet accomplish great things. Yes, 1857 was a turning point in the history of Bengal, and marks the commencement of an era of strenuous effort for the good of her myriad population. The province was vouchsafed a Government of its own, and the creation of a Legislative Council with a right of interpellation on a representative basis gave the germ of institutions worthy of a free and advancing people. Among the earlier Lieutenant-Governors Sir George Campbell stands out as a statesman who raised every branch of the administration to a higher plane. In the teeth of the strenuous opposition of the zemindar class he carried his Road Cess Act, which has given the country a network of internal communication. He reformed the police, and provided the lower classes with the means of primary education. The Marquis of Ripon's Local Self Government Acts form another landmark in the annals of Bengal. They aroused an unexpected degree of public spirit in the upper and middle classes, and gave full scope to Sir George Campbell's reforms. A year later came an attempt to remedy the glaring defect of the Permanent Settlement by conferring fixity of tenure on the cultivators of the soil. As seasons of peace and plenty succeeded each other population tended to outgrow the means of subsistence. As I have already remarked, in 1793 the cry was for ryots; ninety years later it was for land. The legislation of 1884 was framed on an Irish model, and it is, I think, questionable whether the pendulum has not swung too far on the ryot's side. The zemindar is confronted by an iron-bound sale law, which enforces punctuality in the payment of the Government demand under a penalty of ruin. He sees an expeditious mechanism for realisation of arrears of rent at work on Government estates managed by Government, while he encounters delay, expense and chicane in attempting to secure his rights in our civil courts. Sir William Hunter rightly believed that the solution of the great rent law question was to be found in a well-considered attempt to redistribute population, rather than an artificial interference with the laws of supply and demand. With a soil which yields two and sometimes three crops annually, unaided by manure; with profound peace and settled laws there must come a congestion unparalleled in Europe, where the most densely peopled tracts are those which depend on industrial enterprise. In many districts the number per square mile is thrice as great as the English average; while on the fringe of these congested areas millions of acres cry aloud for the plough. There is abundant evidence that some of the automatic checks on the tendency of population to outstrip the means of subsistence which were enunciated a century back by Malthus have come into play in Bengal. The "Moral Restraint" inculcated by that amiable philosopher can hardly be hoped for in a land where early marriage and the propagation of the species are regarded as religious duties, and the law gives every child an indefeasible right to share in the paternal estate. From war and famine Bengal is saved by the strong arm of British rule.

There remains disease in an epidemic form, against which our sanitary authorities struggle in vain. Malaria has always been endemic in these plains; but it was not until 1869 that it attracted attention under the name of "Burdwan fever." It has caused a marked shrinkage in the census returns of some central districts; and Nadiya, which was a sanatorium ere Darjiling was made accessible by rail, is now decimated by this scourge. We have learnt that it is due to a microbe implanted by a species of mosquito which flourishes only in a marshy soil. Thirty years ago Calcutta was mosquito and fever-haunted; now, thanks to scientific drainage, it is as healthy as many a Continental capital. The interior is still suffering from obstruction of subsoil drainage, and the evil is intensified by railways constructed at right-angles to the water-shed, with a very insufficient provision of bridges and culverts. I was glad indeed to see, a few months ago, that true friend of India, Lord Stanley of Alderley, calling attention in the Upper House to this glaring defect, and I fervently hope that his interpellation will open the eyes of our Public Works Department to the responsibility incurred by allowing it to remain unremedied. Drainage is the crying want of the Gangetic plains, and such schemes as have been carried into effect have not only produced untold good but have proved financially profitable. Another plague indigenous to Bengal is cholera. Much controversy has raged as to its origin. I think it demonstrable that, in an epidemic form, it dates from times which may almost be considered our own. For the nomadic instinct in the Mughals led the sovereigns of the House of Babar to spend the greater part of each year in perambulating their Empire, attended by hundreds of thousands of followers. These progresses would be impossible at the present day, for a "camp" on anything like the old scale would speedily be dispersed by cholera. A work describing the origin of epidemic diseases has yet to be written, and he who attempts it will find abundant material available as to the genesis of cholera. In 1816, the reduction of our armaments at home which followed the pacification of Europe let loose a horde of disbanded soldiers and the adventurers of all kinds who thrive during a great war. Some of these men obtained grants of waste land in the Sundarban, an alluvial tract on the fringe of the Bay of Bengal, where nature is still engaged in extending the area of solid ground. In their operations in order to clear the dense forests and bring the virgin soil into cultivation, these pioneers lit upon the cholera germ. In 1817, Jessor, the district to which the Sundarban then belonged, was desolated by this fearful pest, which defied the empiric remedies of our physicians. It spread to Calcutta, dogged Lord Hastings's Grand Army in the campaign against the Pindaris, and proved an adversary more redoubtable than those organised robbers. Then it travelled to Eastern Europe by the caravan routes, striking Paris and London in 1831. One is reminded of the story in the "Arabian Nights" of the unhappy wight who fished up a bottle, whence he released an all-devouring genius. Two facts stand out in high relief in the modern history of cholera. In towns with a pure water supply it appears only in a sporadic form. In country districts it is connected with the tax on salt. The price of that necessary of life is so high that it is seldom given to cattle, which satisfy their craving by devouring the excrementitious matter containing it which is found in the environs of villages. Thus milk, which enters so largely into the dietary of all classes, becomes infected with the cholera germ. The mortality from this cause is sometimes appalling. In 1891 cholera destroyed 150,000 inhabitants of Rangpur who flocked by rail to participate in a great bathing festival, and I personally superintended the burial of hundreds of dead bodies flung from the trains at Parbatipur Junction.

Railways afford a means of redressing the balance of nature. At the outbreak of the Mutiny only 120 miles were open for traffic. Strategic motives led to the rapid construction of trunk lines connecting Calcutta and the Upper Provinces, and in 1871 through communication was established with Bombay. In 1864 the rich districts of the North were opened up by the completion of the Eastern Bengal Railway, which has been extended to the base of the Himalayan range. Madras and Calcutta are now united, and Chittagong, which 220 years ago was within an ace of becoming the provincial capital, now taps the tea-districts of Assam and gives an outlet for exported jute. The people have taken kindly to the innovation, and caste barriers are as accommodating as they always prove when material interests are at stake. The peasants reckon the time by the roar of trains passing over iron girder bridges, which is heard for miles in the deep silence of the plains. They have learnt the principle of fixed prices from railways. When the rural stations were first thrown open to traffic, the booking offices were besieged by a mob of ryots who tried to bargain for the tickets with the distracted clerks. The local lines constructed by Messrs. Martin and Co., of Calcutta, are commercially successful, and the fact that the shares of the Bakhtiarpur-Behar Light Railway have been over-subscribed, shows that capitalists are at last alive to the immense profits to be derived from this class of investment. For less populated tracts the motor-car is invaluable, and an agency for introducing it has actually begun operations in Chutia Nagpur. The effect of railways is seen in a remarkably even range of food prices throughout India, and a great accession to the means at our disposal for combating famine.

The rationale of famines has never been adequately studied either in India or in this country. In 1865-6 the people of the southern districts of Bengal, known as Orissa, were more than decimated, because their food crop failed, and their ports were closed to incoming supplies by the monsoon. Eight years later Behar was saved from the like fate by Lord Northbrook's calm prescience, and the tremendous energy of Sir Richard Temple, displayed under the stimulus of public feeling at home. We are now better equipped for dealing with the incubus, but it is ever present to hamper the administration, and strain the resources of the Empire. What, then, is the genesis of famine: and is it within the power of the State to remove the defects in the social system of India of which it is a symptom? That famine is directly due to the poverty of the people is admitted on all sides. In Bengal, the condition of the middle classes is unsatisfactory, and much of the discontent which finds utterance in the press is inspired by sheer want. In the eastern districts, where there is still an abundance of virgin soil and the fertility of the cultivated area is yearly renewed by silt, the peasantry are highly prosperous. In the west, however, still known by its ancient designation of Behar, rack-renting is universal and millions seldom enjoy a full meal.

Bengal is pre-eminently an agricultural country, and her welfare is bound up in her harvests. The staff of life is rice, of which there are 300 varieties, and so sensitive is the native palate, that it can distinguish between flavours, which our taste pronounces alike insipid. It is an inferior grain which must be assimilated in large quantities to support the human organism, and a population dependent on it is in the same peril in which the Irish peasantry stood before the potato famine of 1846. In case of a failure, there is nothing cheaper to fall back upon. Rice belongs to two categories. The early sort, sown in lands not subject to inundations in spring and reaped in August, and the winter variety, sown in June, transplanted from the nursery to inundated lands, and reaped in November. The latter is the staple crop; and in the amphibious eastern districts it grows with the flood to a height of 12 feet. Now, both harvests, and especially the winter rice, require steady rain at certain periods of growth. In the first weeks of June the south-west monsoon ought to carry inland abundant moisture from the ocean, for then the processes of sowing and transplanting are in full swing. Again, in October, the retreating west winds, commonly called the "north-east monsoon," must bring fertilising rain clouds, for at that precise season the rice is coming into ear. But these humid, rain-giving currents can by no means be depended on. A prolonged break in either spells ruin to the crops over a vast area, and the mechanism of famine relief has to be set in motion. If we had an effective agricultural department in Bengal with experimental farms at selected district head-quarters, we should long since have hit upon a more sturdy cereal than rice. That the ryot is alive to his own interest and eager to adopt real improvements is shown in the universal use of the little iron sugar mills, introduced a quarter of a century ago by some European zemindars at Bihia in South Behar. Under present conditions rice is cultivated in Bengal, not because it is remunerative but from sheer force of habit which may almost be termed instinct. It is followed by the cold weather crops—oil seeds, pulses, red pepper, sugar-cane, and flax. These the ryot regards as his *peculium*, and the source of his humble luxuries; while his rice is swept into the money-lender's garner and doled out to the grower for family use.

It is beyond question that staples unfitted for human consumption and grown for export are trenching seriously on the areas devoted to food grain. The art of reeling silk by the Italian system was introduced into Bengal as early as 1767, and a generation back well-equipped filatures were common in the central and southern districts. This manufacture is on the wane, for carelessness in the manipulation of the worm has placed Bengal silk at a hopeless disadvantage in the struggle with that of Italy and Japan. Indigo is another decaying industry. Its cultivation in Bengal dates back beyond the dawn of history, but it was reserved for British capital to manufacture the much-prized dye-stuff by business methods. At the beginning of last century the province was studded with factories where the lush weed was beaten and boiled, and the precipitate pressed into the familiar cubes of commerce. But indigo has a long tap root, and soon exhausts the soil. In order to secure cheap raw material some planters acquired interests in landed property, and forced their tenants to cultivate a detested crop, and to supply cut indigo at unremunerative rates. Such principles were no longer possible when a reign of law and a new-born sense of citizenship were diffused throughout Bengal at the revolution produced by the Mutiny. An organised revolt against the indigo planters took place in 1860, which has covered the province with ruined factories, each telling of blighted hopes and a desolate English home. Those who weathered the storm accepted the new order of things, and for a time all went well with them. Secure in the presumed monopoly conferred by soil, climate and cheap labour, the planters turned a deaf ear to the voice of science. Not so the chemists of over-populated Germany. Their energy and persistence have elaborated a method of manufacturing indigo by synthesis, which is destined to revolutionize the production of this beautiful dye-stuff. The change cannot fail to be injurious to the province, but some compensation is given for the loss of these old monopolies by the growing popularity of other products. More than a hundred years ago jute was raised from seed in the Calcutta Botanical Garden by Roxburgh, who called it by the equivalent in the Uria dialect, the Bengali words being *Koshtâ* or *Pât*. The cultivation extended slowly, and the nineteenth century had passed its prime ere jute was established as an article of export. Then its production advanced by leaps and bounds, for Eastern Bengal possesses a tropical climate and rainfall, a soil yearly renewed by silt, cheap labour, and every other condition needed for its growth. He who traverses this amphibious tract during the rains sees the villages buried in dark-green vegetation, which is cut at the beginning of August, steeped in stagnant water to destroy the tissue, and beaten in order to disengage the fibre. The latter is a poor fabric, but it is cheap and easily wrought, while the natural gloss enables it to serve as a silk adulterant. Dundee soon obtained a footing as a centre for the manufacture, and its citizens have striven with Scottish doggedness to retain the lead, but Calcutta is a serious rival for the supply of the coarse grades of jute. The right bank of the Hughli is lined for many miles with tall chimneys, and thousands of operatives, who are mostly drawn from the Upper Provinces, are employed in the manufacture of bagging. It is a curious fact that the prosperity of the trade varies inversely with the British harvests. The poorer they are the keener is the demand for American wheat, which comes to us in jute sacks. Tea is another of these new staples. In 1873 it was introduced by Mr. W. H. Verner, of the Bengal Civil Service, into a sub-Himalayan jungle known as the Duars, which is now covered with well-managed gardens competing successfully with the most favoured tracts of Ceylon and Assam. If the man deserves praise who makes two blades of grass flourish where one grew before, of what reward is he not worthy who has converted a haunt of the rhinoceros and wild elephant into the chosen home of a great English industry? Tobacco, too, owes to our enterprise what progress it has made in the Lower Provinces. It is seen in small patches in the purlieus of most Bengali homesteads, and is grown commercially in North Eastern Rangpur on the Kuch-Behar frontier, where it was introduced by an energetic collector nearly 80 years ago. People are not generally aware that Burma cigars are, to a great extent, made of Bengal leaf. Such is the case, for in October Rangpur swarms with brightly-clad strangers from our easternmost province, eager to purchase the bales of rudely-cured tobacco for export. Here is a vast field for foreign capital, which has hitherto been spasmodically employed in places but ill-suited to the growth of the weed.

Regarded as a whole, Bengal agriculture labours under disadvantages which admit of palliation. There is little or no grazing land, and for three months of every year the soil is like iron, and vegetation dies to its roots. Thus the cattle starve; they are miserably stunted, and are unequal to heavy labour. The remedy seems to lie in encouraging the growth of fodder-crops, which give such excellent results in Egypt. A second hindrance is the want of manure. Coal is mined in yearly increased volume on the spurs of the Vindhyan range, but it is exported or used only on railways, steamers and in factories. So overwhelming are the demands of the plough, that very few villages possess a supply of firewood. Hence the cowdung, which ought to be given back to the hungry soil, is used as fuel, and lands unreached by silt are yearly growing poorer. The acre now produces only 800 lbs. of food grain. In the golden days of Akbar, the average yield was 1,400 lbs., and that in England is upwards of 1,700 lbs. Next in importance in the chain of famine causation to an ill-distributed and improvident peasant proletariat I am inclined to place the alarming deterioration in the productive power of the soil, and I think that the process would be retarded if the State were to insist on a proportion of the lands of every village being set apart for fuel and fodder preserves.

I may now say a few words as to the distribution of the products of these fertile plains. The internal commerce of Bengal is on an incalculable scale. Its rivers are blessed with a tolerably steady breeze blowing against their current, and they are ploughed by thousands of clumsy caravels whose form has not changed materially since Alexander the Great's invasion. Railways have intercepted a share of the water transit, but they will never destroy it as they have strangled the canal system of England. Thus the jute, tea, oilseeds, rice, indigo and pulses of Bengal converge on Calcutta, to await shipment on the liner and "tramp" steamers which cover the Hughli's broad bosom. Only a few years back it displayed tier on tier of sailing ships, the finest in the world. But wind can no longer compete with steam as a motive power. Seamanship is a vanishing quantity, and the genuine Jack-tar will soon be as extinct as the Dodo. I fear that in our next naval war we shall find the Germans and Scandinavians who man our merchant marine but indifferent substitutes for the glorious fellows who won Trafalgar and secured our island's liberties.

The bulk of the internal trade is in the hands of foreigners. That in grain is, or was till lately, almost monopolized by a firm of Greeks. Germans are ousting Englishmen from many branches in which they were once pre-eminent; and the Suez Canal has deprived London of much of its importance as a centre for distribution. Wholesale dealings in the interior are, to a certain extent, carried on by Marwaris from Rajputana, who exhibit all the traits, including a passion for gambling, seen in the

Jews in Europe. This neglect of commerce as a profession by Bengalis is deplorable, for they have remarkable aptitude for it. There was one who began life by buying empty bottles from ships' stewards, and ended it in a palace. He owed his fortune to a keen head, a thick skin, and ingratiating manners; but he had qualities of heart which are less common. On learning that a young English merchant was struggling against unmerited ill-luck, he went to the man's bankers and placed £10,000 to his credit, requesting the manager to advance him £20,000 more if needed. This timely help enabled the European to tide over his difficulties. He left India a rich man, but he never knew the name of his benefactor.

This brings me to the character of the denizens of the Lower Provinces, a race which, from Macaulay's days to our own, has suffered much undeserved obloquy. Religion has had a larger share in moulding it than education, though the latter factor is by no means to be disregarded. Hinduism has received a mighty stimulus from railways, which render the Holy Places easy of access from every part of the Province, and many millions of pilgrims renew the flickering flame of faith by viewing scenes associated with their deities' presence on earth. They also give a wider scope to the machinations of religious mendicants, who are among the bitterest foes to our rule. I have reason for affirming that the plot which led to the murder in Manipur of Mr. Quinton, the Chief Commissioner of Assam, was hatched in Calcutta by these social pests, who take the fullest advantages of all the adjuncts of an alien civilisation to propagate their dreams of Hindu supremacy. A creed which was once rigidly closed to every human being born outside the pale of caste now shows a marvellous elasticity, and finds a place for millions of non-Aryan aborigines. Islam, too, has entered the lists as a highly militant cult, and great influences making for Puritanism, a higher standard of faith and action, are at work which call for the close attention of our authorities. The anti-cow-killing riots of nine years back, and the tree daubing which followed were portents of a volcanic condition of things which cannot be disregarded by those who recognise the childish credulity, the gusts of unreasoning passion manifested at times by every Oriental population. Speaking generally, the upper classes are acute, litigious, and prone to faction and intrigue. Their cardinal virtue is a strong family instinct which leads them to perpetuate jobs on a scale unsurpassed even in England, that chosen home of nepotism. Many years ago I conducted an inquiry into charges of misconduct preferred against the head ministerial officer of the local judge's court, whom I convicted of setting regulations at defiance by filling all the subordinate offices with his own kinsmen. I could not help telling the culprit that, though he was very clever, he was not quite smart enough. English bishops of a past generation managed things better, for it is on record that a pair of them were wont to enter into a secret agreement by which each appointed his neighbour's sons and sons-in-law to the fat livings in his gift. Another excellent point in the Bengali character is the charity which maintains a huge army of paupers without the compulsion of poor rates. Bengalis have much poetry in their composition, and their flexible and mellifluous language serves as an admirable literary tool for its expression. They are born actors, with an instinctive love of pomp and circumstance, and this trait ought to have wider scope than is afforded by a rule which is just but colourless and still reeks of the counting-house. Their chief defect is a want of self-reliance. Rarely have I met a Bengali who was not prone to lean on a stronger nature. They are not open to the charge of ingratitude so often hurled against them by Englishmen who have done nothing to evoke it. Nor is the hackneyed taunt of cowardice wholly deserved by the denizens of the Gangetic Delta. Three thousand years sojourn in a land—

> " Where Nature either drowns or burns,
> A desert and a swamp by turns."

have, indeed, sapped the martial ardour of the Aryans. But these qualities are dormant, and would, I think, respond to sympathy and example. Desperate courage was shown by the bands of clubmen till lately maintained by most great zemindars, and the prevalence of agrarian riots, often attended by loss of life, proves that militant qualities still linger in the masses. Burglary is the curse of the Province, and its yearly growth is one of the most sinister features of our times. Now, Dr. Johnson remarked truly that a burglar must needs be a bold fellow, for he faced death as a trespasser and the gallows as a criminal. The pluck shown by schoolboys in the cricket-field, where they stand up bare-legged to fast bowling, and their heart-whole devotion to football give the lie to these ancient calumnies. The Bengali's salvation lies in his power to reverence what is noble in others. He is a hero-worshipper, and in his land it is easy indeed for a ruler to win a people's love. Let the English civilian show some fellow feeling for the dark-skinned myriads around him. Let him master their language and the outlines at least of their creed and social customs. He will assuredly find an eager response to the touch of sympathy, and will leave the Land of Regrets with a reward far higher than any which it is in the power of the State to bestow.

The ryot is laborious, simple-hearted, and charitable. One rarely hears an unkind word of him from Europeans whose calling brings them into close contact with the masses. He is not untruthful except when he comes within the purlieus of those nests and schools of corruption—our Courts of law; and sooth to say, I have heard harder swearing in a London County Court than in any Indian tribunal. The struggle for life has evolved a sharply-defined criminal class; and, as I have already remarked, burglary shows an alarming increase. Now and then the ryot plunges into those faction fights which convulse Bengali villages, and then caution and principle are thrown to the winds. In ordinary times, however, he is honest and law-abiding. Improvidence is his greatest vice, and it is undoubtedly a link in the chain of famine causation. Several years' income is often squandered on a single religious or social ceremony. It is this characteristic which brings the money-lender into play. He is styled in Bengal proper, Mahajan — literally "great man," though the proportion of the confraternity who accumulate fortunes is very small. The place which the Bengali money-lender occupies in rural economy is as little understood as that of his English colleague. The latter exists, and will survive all attempts to eliminate him, because he is a necessary evil. While human nature is what it is, there will always be a percentage of men whose desperate plight forbids them to hope for accommodation from the ordinary banker. Innumerable are the cases in which ruin and dishonour have been averted by recourse to the much-maligned Shylock. Those who joined in the recent crusade against him ignore the proved futility of the Sumptuary Laws, which aimed at making people provident in spite of themselves. They forget that to brand a calling as infamous is to make the victims pay more dearly for the services which it alone can render. India has no banking facilities, as we understand them, outside the presidency capitals and half-a-dozen important business centres. The mahajan is the ryot's banker. He sweeps into his garner the whole of his client's rice-harvest, and doles out to him what is required for seed-grain and domestic consumption. He pays the rent, and lends the wherewithal for marriage and funeral expenses. In return for these services the mahajan charges his client 30 to 75 per cent. This rate may seem excessive, and it undoubtedly cripples agriculture, but, on the other hand, the risks run by the banker are enormous. Ryots who are hopelessly deep in his books often flit by night to a distant village, or go over, bag and baggage, to a rival banker. Civil justice is expensive, dilatory and venal, and the uncertainty of life is great in a country where grey hairs are seldom seen. Rather than embark on a hopeless attempt to legislate the mahajan out of existence, let us give a trial to Sir William Wedderburn's scheme for establishing agricultural banks. Loan societies already exist at many district headquarters, and return satisfactory profits. A judicious extension of the system would lead to a great reduction in the interest paid on agricultural loans. But no attempt to establish co-operative credit societies can succeed which disregards existing agencies or competes with them. Those who aim at revolutionising the finances of Indian rural economy, must range the mahajan under their banner. They must utilize his special knowledge and supply him with capital, limiting, if need be, the rate of interest charged on advances.

If space admitted, I would enlarge on the characteristics of the white and mixed population of the Lower Provinces. The little knot of exiles who labour in these plains, are under serious disadvantages as compared with their colleagues in the North West. The climate is uncongenial to the European constitution, and the separations between husband and wife, parent and child, are longer and more intolerable than in the other satrapies. He who is doomed to pass his best years in the central or eastern districts, lives in a dark and dilapidated bungalow, and has few social pleasures to vary the round of soul-depressing routine. All honour to the men who nobly do their duty is such surroundings. Their countrymen at home should keep a warm corner in their hearts for such as they, and endeavour to alleviate their lot. Time was when the growth of the Eurasian population was a problem of pressing urgency. The compiler of the "East Indian Vade Mecum," a guide book for young soldiers and civilians, which appeared early in last century, estimated that Bengal, which then included our Upper Provinces, contained but 300 women of pure European descent. The inevitable result of this disproportion in the sexes was the formation of illicit alliances with native females, and the rapid increase of a breed which certainly did not epitomize their parents' virtues. Things have changed on the whole for the better, for Europe is reached with such ease, that many an English girl is tempted to accompany her husband to Bengal, and give him the inestimable blessing of a refined home. But the plight of the Eurasian is still a pitiable one. He is contemned by native and European alike. He often lives in squalor and penury, and his children start in life without Christian or even moral training. With these disadvantages it is marvellous that many Eurasians should show the sterling qualities of their white ancestors. That such is the case I was fain to admit after considerable experience of their work while I was at the head of the Calcutta Custom House. All things considered, I think that their best chance lies in leaving a land which must always be a harsh step-mother to them, and seeking their fortunes in a pacified South Africa. The Government which organised a system of State-aided emigration for families of mixed blood would confer inestimable benefits on India and our African colonies.

Such is a brief and necessarily imperfect sketch of "Bengal—the Land and its People." I trust that its omissions will be supplied by the experiences of my late colleagues whom I see around me, and whom I heartily thank for their presence in this room.

DISCUSSION.

The CHAIRMAN expressed regret at the absence of Sir Richard Temple, who was to have taken the chair, and who would have added to the information and picturesque description which had been given by Mr. Skrine. The Chairman congratulated the audience on the interesting paper which had been read, and Mr. Skrine on the bright way in which he had rapidly surveyed the history of the country, and on his truthful description of the Bengali character. There were, however, several points in the paper with which he did not entirely agree. He thought Mr. Skrine was a little hard upon the East India Company in considering that they did nothing for the commercial benefit of the country. Of the two specific commodities alluded to by Mr. Skrine the introduction of tea was really the work of the East India Company. They, first of all, started the Government plantations in Assam, and as soon as the thing was found to be a commercial success it was handed over to the Assam Company. Indigo was introduced by the East India Company in their commercial days, and there were yet one or two of the old factories in Behar which were formerly the property of the Company. Mr. Skrine was also, he thought, a little unfair in saying that there were no roads in Bengal except strategical ones before the Mutiny. Although the roads were not plentiful, there were district communications almost in every part of the province, not made for strategical purposes, and giving great facility to commerce. Another correction he wished to make was with regard to the separate government given to Bengal; this was given three or four years before the Mutiny, and not after that event, as stated by Mr. Skrine. With regard to the panic in Calcutta on what was called "Black Monday," his own recollection was that it was called "Panic Sunday." He was living in Calcutta at that time, but was absolutely ignorant of the whole affair until some time afterwards. He was at that time in charge of the Alipur Gaol, and as the native sepoy guard had been disarmed that day, and no other guard had taken its place, he had to spend the night there. On the following morning he went back to his house, but neither then, nor for some time afterwards, did he know anything about the panic. He learnt subsequently that a number of the poorer Europeans and Eurasians, living in the suburbs of Calcutta, such as Intally and Sealdah, had gone to the Fort and to the ships, but a great deal too much had been made of the affair. Mr. Skrine had the sanction of tradition for his statement, and it would no doubt become authentic history, but it was not a fact. With regard to Mr. Skrine's belief that there was a close connection between the price of salt and the spread of cholera, he thought it was based on two or three very large assumptions, the assumptions being, first, that if the salt was cheaper the natives would give it to their cattle; secondly, that if the cattle had salt given to them they would not eat excrementitious matter; and, thirdly, having eaten, that the cholera was necessarily distributed through the milk. There were more likely ways of distributing cholera than through milk. It was a water-borne disease, and it was scarcely possible in country districts to prevent water getting foul. Mr. Skrine might have said something about the labours of Government officials in their endeavour to stem cholera, to mitigate its ravages, and to assist the people afflicted with it; and the labours of Messrs. Hankin, Haffkine, and others were deserving of mention. With regard to famine, Mr. Skrine thought the rationale of it had not been adequately studied, but really the best intellects in India had devoted years to the study of it, and the genesis was given nowhere more clearly and more succinctly than in the paper. Mr. Skrine quoted Sir William

Hunter as having expressed the opinion that a better distribution of population was the real remedy. It might be so, but the people had never shown the smallest willingness to migrate, and every attempt on the part of the Government to assist migration had been a dead failure. The remedy suggested in the paper might come about some day, namely, that some 70,000,000 of Bengalis should give up eating rice and take to some other and more sturdy cereal. It would be an admirable thing if it could be done, but the work was beyond any agricultural department. He warmly sympathised with the view taken by Mr. Skrine of the Bengali character and disposition. He also agreed as to the utility of the mahajan in the economy of Bengal. The mahajan was absolutely essential to the agricultural life of Bengal. He also agreed with Mr. Skrine's views on the subject of agricultural banks, with a little modification. The proposal of Sir William Wedderburn was a very valuable one, and carefully and sympathetically considered by Lord Ripon's Government. It was only when the scheme came to be worked out in detail that it was felt that it could not be introduced in the shape it had been given. The matter had been again taken up, and experiments made in the Punjab and Madras, and at present there was an important Committee sitting to consider the question of introducing legislation, but if so it would probably be on lines somewhat different from those of Sir William Wedderburn's scheme. He suggested that Mr. Skrine in a paper at some other time might take up certain other points of great interest in a description of Bengal, especially the question of the absorption of the non-Aryan tribes into Hinduism. Such absorption was tolerably complete amongst the sub-Himalayan tribes, and could be seen in process in Manipur and Kuch Behar. One change of the seat of Government had been referred to by Mr. Skrine, but the whole question of ruined cities was connected with it, and it would be very interesting if Mr. Skrine could deal with that matter also, as it appeared to the Chairman that there must be some natural law at work to account for the abandonment of large cities.

Sir CHARLES CECIL STEVENS, K.C.S.I., said that in a book which Mr. Skrine had lately written, he attributed a great deal of the success of two very distinguished members of the Civil Service to the fact that they had served for a time under Sir William Hunter. He (Sir Charles Stevens) wished that he in his turn could claim that his precept and example had been an important factor in those qualities which Mr. Skrine displayed, for he knew Mr. Skrine in his very early days when he was a sub-divisional magistrate in the district of which he (the speaker) was chief magistrate, and he could confirm all the Chairman had said regarding Mr. Skrine's great energy and his anxiety to be always doing something for the good of the people. Occasionally his energy caused a little anxiety, but the people who were most affected by it had never taken exception. The ground traversed by Mr. Skrine was so very extensive, and Sir Steuart Bayley had anticipated the speaker in what he had intended to say to such an extent that he could only offer a few disjointed remarks. Mr. Skrine had given an admirable sketch of the early history of Bengal, and there was little in it that was open to objection, but there was one point on which he (Sir Charles Stevens) held a decided opinion. He thought Mr. Skrine was unjust to the earliest British invaders of Bengal when he spoke of them as "timid traders." About two and a half years previously he had had the honour of reading a paper in that room on the subject of Calcutta; in preparing that paper he had read a great deal of the early literature regarding old British times, the result of which was to convince him that, whatever faults they displayed, the early English settlers showed no timidity. On the contrary, the incidents of the very first landing of Cartwright in Cuttack were characterised by exactly the opposite line of conduct. The selection of Calcutta was due to the fact that the traders found it necessary to build a fort, as the British had done in Madras and Bombay, and the Calcutta site was selected partly for reasons of trade, and partly because it was protected on the west by the swift Hugli, and eastwards by a trackless swamp known as the Salt Lakes. In fact, it was a military as well as a trade capital. Mr. Skrine had pointed out that in the old days there was a competition for ryots and not for land; this condition of affairs had not disappeared, but in some localities existed even to this day. In the province of Chota Nagpur, for example, the chief had the most lively sense of the necessity for getting and keeping ryots. A chief would attract the ryots from the districts by extremely liberal terms; and the first sign that the chief was putting too much pressure on his people was the ryots beginning to leave him. Another important reform had been carried out in addition to the abolition of *Sati* and that was the abolition of hook-swinging in Bengal. In the course of his first year in Bengal he had witnessed this performance, but nothing of that kind ever took place now, or, if it did, it could only be on the smallest scale, and in the most secret manner. Mr. Skrine had said that "Young Bengal has made the fatal mistake of regarding education rather as an act to compass definite worldly ambition than as enabling the unborn mental powers to serve the purposes of self-culture and the good of others." This was taking very high ground—higher than is taken in England, or than we take for our own families. The first object is to attain the means of living, and the Bengalis could hardly be blamed for doing what is done by boys and even girls in England. With regard to the defect of the educational system in its neglect of technical education, Mr. Skrine himself had, in at least one district, endeavoured to remedy that defect, but it was one that could only be remedied very gradually. Before technical training could be widely extended, it was necessary to create a demand for the product, and the demands of the Bengali ryot were very simple. He agreed with Mr. Skrine in his estimation of the work of Sir George Campbell; his methods were not altogether appreciated at the time, but there were now very few people in Bengal who would not acknowledge with gratitude the great advantage derived from Sir George's incumbency, and, generally, it was a very good thing that occasionally an outsider should serve as Lieutenant-Governor in a province.

Mr. W. S. SETON-KARR felt some little hesitation in following two gentlemen who had held such high positions in India. He mentioned a fact which was perhaps not known to everyone, namely, that Sir Steuart Bayley and his much-respected father had served as instruments in the Government of India for a period which covered 110 years. He (Mr. Seton-Karr) thought there were one or two points in the paper on which side-light might be thrown. First, there was the case of Clive. In those days the Civil Service had not the strict standard of integrity it attained to in after years, and it was a common thing for the council who overthrew one interloper and put in another to receive large presents. When Clive was examined before the Committee of the House of Commons he made no secret of what he had received. With regard to Warren Hastings, Sir Frederick Halliday, whose recent loss was deplored, had had the good fortune to talk to a native who had been a witness of the duel between Francis and Warren Hastings. It took place in the grounds of the European Female Orphan Asylum, and the account of the duel was so pithy that it was worth while mentioning. The native said there had been a great row between Hastings and Francis as to who should be Governor; they challenged each other: Hastings fired, Francis fell, and from that moment Hastings was Governor of the country. Something had been said about the poverty of the people and the difficulty in getting them to migrate. He agreed with a great deal of this, but thought the main cause of the famines had been a deficient rainfall. With a good rainfall, things would go on perfectly well, but when the rainfall was deficient, it taxed all the resources of India, to afford a gigantic poor-law relief. He was inclined to agree with Mr. Skrine with regard to roads, as when he first went to India, the Grand Trunk road was just being metalled. All the roads were then unmetalled, and in the rainy season became literally impassable. Bengal was the milch-cow of the empire, and was neglected, although much was done for the Upper Provinces, and it was only by the creation of Lieutenant-Governors that progress was made at all. The main credit in stopping the Mutiny at Jessor, belonged to the Magistrate, Mr. Molony. With five Englishmen, Mr. Molony locked up thirty-five military police, and one execution took place. As to the introduction of European capital, he had always welcomed such introduction if it was under a proper system. There was nothing more sad than to contemplate the collapse of an Indian industry. Sir Bartle Frere, some years ago, in discussing the subject, said that the presence of independent and unofficial Englishmen in the interior of the country, did not always render the administration easier, but their presence in times of peace was a source of prosperity, and in troublous times it was an element of security and strength. When the English took Bengal, they had a very imperfect knowledge of what had to be done. They did not realise the splendid inheritance, and no doubt at first made mistakes, but those mistakes were followed in the next generation by part successes, and in the third generation by what were triumphs of administration. He was not one of those who indulged in indiscriminate abuse of natives, and had always preferred to dwell on their aptitude for business and their gratitude; and he did not care to ransack history for instances of Asiatic turpitude or Oriental treachery.

Sir CHARLES STEVENS here took the chair in succession to Sir Steuart Bayley, who was called away.

Mr. T. DURANT BEIGHTON said that the two subjects on which he wished specially to speak were tea and famine. No doubt the reader of the paper was accurate in saying that Mr. W. H. Verner was the first person to introduce tea into Jalpaiguri, but in justice to himself he (Mr. Beighton) wished to say that when he joined that district of the Duars as Deputy-Commissioner in 1876 the number of gardens was only six or seven, but during his incumbency they increased to 50 or 60. As a matter of fact when he entered the district there was no system for regulating the leases, the area, or the conditions on which the tea planters were allowed to grow their product, and he was the first person to appoint surveyors. The present condition of the industry was very serious. Over-production had glutted the markets of the world, particularly the British markets, and the planters had not the power of combination of which he should like to see them possessed. They should borrow a little of that aptitude from the other side of the Atlantic for the making of trusts. The tea planters of Ceylon and the tea planters of the Tea Association of Calcutta ought to combine and take some steps in the direction of effectively limiting the output especially of low grade teas and of getting rid of some of the evils which undoubtedly now affected the conduct of the business. There were several things pressing very heavily upon the tea industry. Unfortunately there was a controversy between the present Chief Commissioner of Assam and the tea planters, into the merits of which he did not for a moment intend to enter, with regard to the wages which were being paid to labour, and with regard to certain returns, all these things helping to depress the industry. Low prices consequent on the want of enterprise in finding new markets had certainly brought about a state of things which he was sure everyone regretted to see. He wished to enter his emphatic protest against any further burden being put upon tea. Of all the industries which had flourished since our rule had commenced, that of the tea plantations had been upon the whole of the greatest good to the over-weighted population of that country. No doubt, when the gardens were first opened up, there was a certain amount of deadly malaria, but after that he believed there was no healthier occupation or an occupation more conducive to long life and prosperity of the coolie, his wife and family, all of whom found remunerative employment, than employment in the gardens and tea estates. There was the further great advantage that it removed the population from congested areas and permanently settled them where their labour was required for the development of the country. With regard to the question of famine, he noticed that the reader of the paper carefully avoided stating what other cereals should take the place of rice, and he did not believe for one moment the natives would ever give up rice. He differed not only from the reader of the paper, but from Sir Steuart Bayley, with regard to the mahajan. No doubt the mahajan was at present necessary, but he was as certainly a necessary evil. It could not be conducive to the prosperity of the country that the enormous rates of interest should be charged by the money-lender. Public opinion had altered entirely of late years on the desirability of imposing legislative checks on exorbitant interest. He ventured to suggest two safeguards against famine. The first of these was a possible great increase in emigration to the British colonies. At the present moment there were no less than 135,000 persons of Indian descent settled in British Guiana with their wives and families; no less than 7,000 coolies had gone to Natal last year in spite of the war, and 7,000 had gone to Trinidad. Those figures were very small as compared with the enormous masses of India, but when the sugar industry revived, as he trusted it would, if the bounty system was not abolished by the Brussels Conference, by the Government taking the statesmanlike step of putting on countervailing duties, then there would be an enormous scope for the migration of the natives of India to those Colonies. Great Britain was the only nation, as far as he was aware, who had declared in the solemnest terms, and had laid it down as one of the axioms of administration that no native should die from the effects of famine. It was an heroic determination, even if rather a counsel of perfection, and he should like to have congratulated Sir Antony MacDonnell, who had left the room, on having successfully carried it out in his attempts to grapple with the terrible famine in the North-West Provinces. Having laid ourselves under this obligation one might attach certain conditions to the granting of relief. Persons who were in receipt of actual parochial relief from the Government were not entitled to quarrel with the conditions on which that relief was given. Sir Steuart Bayley had told them that the scheme of Sir William Wedderburn, alluded to by the reader of the paper, was found, to the regret of the Government, to be impracticable in detail. But something apparently similar in principle was, if the papers were to be believed, to be inaugurated by Lord Curzon. He referred to the establishment of a Co-operative Agricultural Loan Society, a sort of Land Mortgage Bank for the poor, which would help deserving ryots with loans at moderate interest. He could not see why a society like this should not compete with the usurer, or why an unholy alliance should, as suggested, be made between Government and the moneylender. Sir Steuart Bayley further said, that it was impossible to induce the peasants to emigrate; but he (the speaker) suggested that compulsory redistribution should be a condition of relief in famine. India was not altogether an over-populated country, as there were millions of acres only waiting the hands to cultivate them, and one condition of the natives on the thickly-populated arid soil receiving relief should be their removal to the more fertile and less populated districts.

The CHAIRMAN, in thanking Mr. Skrine for his interesting paper, associated himself unreservedly in what had been said by Sir Steuart Bayley and the reader of the paper regarding the Bengali character. Speaking on the subject of Eurasians, he considered the great difficulty arose in no small degree from the infinite gradations of the people who were called Eurasians, ranging from something hardly higher than comparatively low caste natives up to men and women who were not distinguishable from Europeans, and who had risen to high distinction and eminence.

Mr. SKRINE briefly acknowledged the thanks which had been tendered to him, and the proceedings terminated.

EIGHTH ORDINARY MEETING.

Wednesday, January 29th, 1902; CAPTAIN EDWARD PARTINGTON, J.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Buckney, Daniel, 51, Highbury-park, N.
Gallenkamp, Adolphus Charles, 19 and 21, Sun-street, Finsbury-square, E.C., and 106, Mount Pleasant-lane, Upper Clapton, N.E.
Keller, Francis, The Limes, Sarisbury-green, Southampton.
MacDonnell, Sir Antony Patrick, G.C.S.I., 186, Cromwell-road, S.W.
Paterson, John, 1, Walbrook, E.C.
Ross, Sir Charles H. A. F. L., Bart., D.L., Balnagown Castle, Parkhill, Ross-shire, Scotland.

Walter, Mrs., Bear Wood, Wokingham.
Wiener, Augustus Frederick, 4, Bedford-place, Russell-square, W.C.
Woolf, Joseph, jun., 32, Victoria-street, S.W.

The following members were balloted for, and duly elected members of the Society:—

Aitchison, James, 14, Newgate-street, E.C.
Allen, Henry Charles, River Plate House, Finsbury-circus, E.C., and 31 Maresfield-gardens, Hampstead, N.W.
Barber, Walter Maw, 20, Woodland-road, New Southgate, N.; and Toronto, Canada.
Bowles, Lionel Oliver, Tipling Ghat P.O., Dibrugarh, Assam, India.
Brenan, Byron, C.M.G., Royal Societies' Club, St. James's-street, S.W.
Chase, March F., The Mineral Point Zinc Co., Mineral Point, Wisconsin, U.S.A.
Child, Arthur Blackburn, The Galway Electric Co., Ltd., Newtownsmyth, Galway, Ireland.
Das, Radha Charan, Balasore, India.
De Fenzi, C. W. P. Douglas, Inns of Court Hotel, High Holborn, W.C.
Goodbun, John Percy, Southcote-house, near Leighton Buzzard.
Harris, Henry, Wyoming, 61, Wood-vale, Honor-oak, S.E.
Hawksley, Kenneth Phipson, 30, Great George-street, S.W.
Leeming, John, F.R.I.B.A., Victoria-house, 117, Victoria-street, Westminster, S.W.
Leeming, Joseph, F.R.I.B.A., Victoria-house, 117, Victoria-street, Westminster, S.W.
Manton, Arthur Woodroffe, B.Sc., M.Inst.C.E., M.Inst.M.E., Chipping Sodbury, Gloucestershire.
Menon, C. Gopal, 273 Linghi Chetty-street, Madras, India.
Mosenthal, George Joseph Samuel, 190, Queen's-gate, S.W.
Munford, J., Kensington College, 143–145, Queen's-road, Westbourne-grove, W.
Muthusawmy Iyer, C.V., Cumbum, Madura District, Madras, India.
Pownall, W. O., The Guildhall, Westminster, S.W.
Randall, Joseph, Warren-lane Works, Woolwich, S.E.
Randolph, Professor Lingan Strother, M.Am.S.C.E., Blacksburg, Virginia, U.S.A.
Roy, Kumar Ronendro Narain (Bahadur of Bhawal), The Palace, Joydebpore (E.B.S. Railway), East Bengal, India.
Stewart, J. Erskine Meysey, Gas and Electric Lighting Offices, Leicester.
Symon, Alexander, F.R.I.B.A., Arbroath, Scotland.
Thompson, Charles, J. Warren Bank, Brampton, Cumberland.
Thorne, William, Rusdon, Rondebosh, Cape Town, South Africa.
Topham, Thomas Edward, Assoc.M.Inst.C.E., Natal Government Railways, Durban, Natal, South Africa.
Willcocks, William, Cairo, Egypt.
Wood, John T., Registrar of Mining Rights, Castle-buildings, Johannesburg, Transvaal Colony, South Africa.
Young, Clyde, 6, Lancaster-place, Strand, W.C., and Bristol-lodge, Putney heath, S.W.

The CHAIRMAN, prior to the reading of the paper, referred to the great changes which had taken place in paper-making during the last thirty or forty years. Paper now had to be made at such a speed that the old methods were not available, and the material once used had had to give place to raw material more easily worked and more plentifully produced, such as esparto, which had been an inestimable boon to the industry. The rule of thumb methods of the past had disappeared in favour of a scientific manufacture, chemistry, mechanics and electricity, being pressed into service, a knowledge of these sciences being essential, not only to managers and foremen, but even to the workmen themselves. In conclusion the Chairman expressed the great pleasure it gave him to preside over the meeting. Competitors in the paper trade were exceedingly active, and such meetings afforded valuable aid in assisting the manufacturers of this country to hold their own in the paper markets of the world.

The paper read was—

TECHNICAL EDUCATION AS APPLIED TO PAPER-MAKING.

BY CLAYTON BEADLE.

I am not aware that any attempt has, so far, been made to discuss the general bearing of "technical education" in its relationship to paper manufacture. The constitutional peculiarities of paper-making render it all the more necessary that this subject should be discussed strictly on its own merits, and not merely as part of a general scheme for technical education. The national advantages possessed by such countries as the United States and Scandinavia, to whom our markets are laid open, expose us to a fierce competition and rivalry, and render it all the more necessary for us to do all that lies in our power to foster technical education, to insure the utmost economy and efficiency of working, as well as to keep up the quality of our products.

I do not claim originality in the views and statements which I am about to put forward. On the contrary, I wish it to be understood that they have been gleaned from various sources, as the result of my contact with members of the trade. I feel that the subject is now ripe for discussion, and if this paper is the humble means of initiating a discussion, I shall feel amply justified in bringing it before your notice.

There appear to be differences of opinion as to what technical education comprises. These two words, "technical education," are in the mouth of all those who discourse on the subject of education generally. For a legal definition of "technical education," I would refer you to some recent utterances of Lord Salisbury, in which he points out, that even the State definition by Act of Parliament is somewhat vague. Technical education is really "special education," and in my opinion, might well be defined as "education designed on behalf of any special calling."

The subject of technical education generally, is only just beginning to assume definite shape. There appear to be no books on its general principles other than official books. I have been unable to find a single book devoted to the subject generally. This appears to be strange, because there are general principles which underlie technical education, as applied to all subjects. This is evident to anybody who has studied the subject, even superficially. A book which could demonstrate the general principles, common to all departments of technical education, would be of great assistance to technical instructors and students, and would tend to bring about a uniformity in the methods of teaching various subjects. At present I venture to think there is little uniformity in the method employed by teachers of different subjects, to say nothing of those employed by teachers on the same subject in different parts of the country.

The question, therefore, that confronts us is: How are we to so design and apply education so as to render it of efficient service in the manufacture of paper? I will not pretend to give a solution to this question, but I sincerely hope that my remarks may lead those chiefly interested in the matter to give it their most serious consideration, and that by so doing some useful progress will be made.

I have already made an attempt through the medium of the *Paper Maker* in my articles on "Technical Education as applied to Paper-making" and "Chemistry and Paper-making," to discuss the subject in its general bearings, and some of the following remarks have already appeared in the articles above referred to.

CHEMISTRY AND ENGINEERING.

In order to assess the relative importance of Chemistry and Engineering, for the purpose of paper-making, it is necessary to consider briefly the conditions of the paper trade in this country.

Prior to the introduction of "chemical" and "mechanical" wood pulp, the whole of the chemical as well as the mechanical operations were conducted in the paper mill. Of recent years, however, a great change has taken place. Wood, which now forms a large bulk of the material used for paper manufacture (and is likely to form even a greater proportion of the materials used in the near future), is now chemically and mechanically treated close to the sources of the supply. The consequence of this is that the whole of the mechanical and chemical operations involved in the conversion of timber into wood pulp, are no longer conducted in this country, but have to be performed in the United States, Canada, and Scandinavia.

All those who are engaged in the paper manufacture in this country, and likely to remain here, do not necessarily require a knowledge of these processes, although it is advisable that they should know as much as possible of the treatment of the raw material prior to their receiving it for conversion into paper. This country is cut off from performing a large proportion of the chemical treatment, and now gives its attention more strictly to the actual paper manufacture, leaving the treatment of much of the raw material to other countries.

I venture to think that too little stress is laid upon the engineering aspect of paper making. It is generally conceded that chemical knowledge is indispensable, but in my opinion, mechanical knowledge is equally a necessity in modern paper-making. Paper-making may be regarded as a species of chemical engineering. Dr. Witt,* in his paper before the International Congress, held at the Society of Arts in 1897, remarked,—"Dyeing, calico-printing, and paper-making, are perhaps the only chemical industries which may rightly claim the necessity of some special instruction in the methods of their manipulation." Notice that Dr. Witt describes paper-making as a chemical industry.

As regards the necessity for engineering in so called chemical industries, I would draw your attention to the remarks made by Mr.

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* "Relations existing between the teaching of Pure Chemistry and Applied Chemistry," by Otto N. Witt, Ph.D., at the International Congress on Technical Education.

G. E. Davies, in his excellent treatise on "Chemical Engineering." He endeavours to trace the influence of a qualified engineer being at the head of affairs in a chemical industry such as in "Alkali Making." One would almost judge from his remarks that in such a case he considers engineering of paramount importance, if not of equal importance with chemistry.*

There are many intricate chemical operations involved in the manufacture of paper, but, in spite of this, paper-making is very largely a mechanical operation. A proper understanding of either the chemical or mechanical operations necessitates a knowledge of both chemistry and engineering, in consequence of it being impossible to separate the two branches of paper-making one from the other. The machinery of a paper mill is also intricate and of a very diversified order. From a structural point of view alone, and for the purpose of repairs and general up-keep of the mill, managers, foremen and others in responsible positions should certainly have a considerable knowledge of engineering.

CHEMISTRY AND CONSTITUTIONAL DIFFICULTIES.

Science is making strides year by year, but it must be remembered that the acquisition and accumulation of scientific knowledge is a far easier thing than its industrial application. It is hard enough to apply chemical knowledge to working out and developing some new industry, even in the case of some chemical industry, but it is far harder to apply chemical knowledge to an old-established industry like paper-making. The art of paper-making (at any rate up to the middle of the last century) had been acquired almost without the aid of chemical knowledge. Many of the most successful paper-makers the world has ever seen had no chemical knowledge whatever. Moreover, a prejudice has been engendered against science by those men who had made themselves successful without it assuming that it was unnecessary, and teaching others to believe so. I would furthermore mention another difficulty, largely as a consequence of the foregoing, namely, that paper-making being the outcome of rule-of-thumb practice, is constitutionally unscientific, and in a large measure unfit to receive help from chemistry. These are some of the constitutional difficulties which confront us. I call them constitutional advisedly, as I wish to urge that educational advance will be largely influenced by constitutional changes, or retarded by constitutional inactivity.

PAPER-MAKING AS A PROFESSION.

If we look at other industries that are as old as paper-making, but at the same time amenable to scientific treatment, we find that they have been transformed into truly scientific operations. Take, for instance, the operations of mining and the manufacture of iron and steel. These operations have been studied in the minutest details by eminent engineers, and also by the leading metallurgists and chemists in all parts of the world. The result is that their general principles are taught daily, and national institutions have sprung up where first-class training can be got, and young men thus educated are able to start their career with a thorough knowledge of the art or craft of their profession. By such means, mining and engineering have been raised to the rank of professions.

These professions gave rise to such powerful bodies as the School of Mines (now the Royal College of Science), especially for the education of young fellows who devote their lives to mining operations; the Institute of Civil Engineers; the Institute of Mechanical Engineers; the Iron and Steel Institute, &c., to say nothing of the bodies devoted to electrical engineering.

When we can bring about this much to be desired change, not necessarily in the actual manufacture of paper itself, but in our mode of regarding the principles of its manufacture, and in our mode of enunciating, demonstrating, and treating them, then and not till then can we rank paper-making side by side with other so-called professions.

THE RELATION OF THE CHEMIST TO PAPER-MAKING.

I venture to think that the national prosperity of paper-making in this country will largely depend upon the attitude of the paper-maker to the chemist, and the attitude of the chemist to the paper-maker. As this relationship must also affect the educational question, I think it deserves special consideration. The resident chemist, or, more correctly speaking, the person responsible for the routine chemical work of the paper-mill, should exercise more influence than he is able to exert at present. I am strongly of opinion that, in spite of the indifference of the paper-maker to science, the resident chemist has been largely to blame for his non-success. In many cases the chemist is not a properly qualified man, he is not at all practical, he is by no means a disciplinarian in his work, and he seldom carries his work to a satisfactory issue. The chemist is too often a dabbler who, when he is set to work out some problem, does it in a half-hearted way. He, perhaps, succeeds on a laboratory scale, and is not sufficiently in touch with the practical man to be able successfully to accomplish his work on a large scale.

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* " . . the fact was not be ignored that the engineer with a little knowledge of chemistry generally was more successful than the chemist with a smattering of engineering, which goes a long way to prove that the engineering knowledge was the more valuable of the two." "A Handbook of Chemical Engineering," by G. R. Davis, Part I., page 2.

I venture to think that it is a mistake for the chemist to content himself with a knowledge of chemistry only; it is advisable that he should be a good draughtsman and have some knowledge of engineering. Further, it is important, if not essential, that he should have had a thorough drilling in the paper-mill. How often has a manufacturer taken a young fellow possessing a good elementary training as a chemist, and met with nothing but disappointment. It sometimes happens that a young man of this stamp will rise to the occasion, and instinctively acquire a technical grasp of the particular manufacture to which he is giving his services; but such men are few and far between, and it is consequently a dangerous experiment to employ a man under such conditions.

On the other hand, the chemist is often left too much to his own devices by the practical paper-maker. He is not called upon to give sufficient account of himself and his work, and is left to study what problems he likes. It is only when something for which the chemist is supposed to be responsible goes radically wrong that he is brought to book. The appliances at the disposal of the resident chemist are, as a rule, altogether inadequate for useful work, and as the equipment that a chemist requires for paper-mill work is not expensive, there can be no excuse for his not having what he requires. I am inclined to think that the chemist is partly to blame for not adequately equipping his laboratory for the work he has to do.

DUTIES OF WORKS CHEMIST.

The foundation of the work of a resident chemist should be routine work, undertaken at the instance of the principals of his firm. The work should be carefully chosen, care being taken, of course, that no unnecessary work is done. There are many tests that should be undertaken as routine work, either daily, weekly, or fortnightly, as circumstances warrant. The laboratory should be so equipped as to render this work as easy and rapid as possible. Records of the tests should be kept in books, to which members of the firm can refer, and there is no reason why they should not be entered with as much regularity and precision as entries are made in the day book or ledger in the counting-house. The rapidity and precision of routine chemical work is largely dependent upon the choice of suitable methods.

When certain observations become matters of every day routine, it is possible so to arrange the work as to reduce labour and minimise the possibility of error. An investigation should be conducted in such a way as to bring into due prominence the particular point requiring elucidation. A chemist will sometimes take too much pains over details that have no bearing whatever on the point at issue; this, of course, is a great waste of labour.

There are many questions relating to paper-making that are extremely complex, and a chemist should form no judgment, except after repeated verification of his results. In bringing his results before a practical paper-maker, if need be, the chemist should present his figures in such a way as to be thoroughly intelligible to an unscientific mind. The choice of work should have very careful consideration. In this matter the chemist should be largely influenced by the practical paper-maker. The work might be conveniently divided under three headings:—

(1) Routine chemical work.

(2) Special investigations.

(3) Research work.

No. 1 should be undertaken first, No. 2 as occasion requires, and No. 3 as time and circumstances permit. Under the heading of No. 1, there are, I should judge, twenty lines of work applicable to any paper-mill. Under No. 2 must be included all special work that the chemist is called upon to undertake from time to time, such as the testing of any new process. No. 2 will be a greater test of the chemist's capabilities than No. 1.

The research work should be entirely spontaneous on the part of the chemist. If he has the time and opportunity, he might undertake investigations on his own initiative, and he should not be discouraged from so doing by his employers, so long as the work in question has some important bearing on paper-making.

My reason for stating that a chemist should be something more than a chemist, are as follows:—He should certainly be able to do such things as indicate a steam engine, conduct boiler trials upon the evaporative efficiency of fuels, or determine the relative efficiencies of different types of furnaces, &c.; unless he is somewhat of a mechanic, he will not be able to make special appliances required for his investigations, or to instruct others to do so; unless he is a draughtsman, he will not be able to make his own designs or submit drawings to his principals. Unless he has actually been drilling in paper-making, he will most likely content himself by testing a process on a laboratory scale only. With practical experience of industrial processes a man, however scientific, if properly balanced, will not be contented with laboratory investigations alone; he will regard such work as stepping-stones only, and proceed to repeat his experiments on a more extended scale, and under conditions which obtain in practice. Then, and not till then, can he feel the least assurance of success on an industrial scale.

I have said enough in reference to the duties and responsibilities of a paper-mill chemist, but the primary responsibility appears to rest with the practical man. How is it that most paper-makers have no resident chemist at all, whilst others have men who are mere dabblers, who, absolutely devoid of system, do just what they like and leave the rest? Whose fault is it that such is the case? I venture to think that the paper-makers are partly to blame for not employing thoroughly good men, and placing the necessary appliances at their disposal. Such men will be forthcoming if the paper-makers show more desire to enlist their services.

THE WANT OF EDUCATIONAL OPPORTUNITIES.

The student who desires to instruct himself, either for his general advancement or for the purpose of passing the City and Guilds of London Institute Examination, is confronted with many difficulties, and it is as well that these difficulties should be appreciated. He is more likely than not to be living in some out of the way place where he is dependent entirely upon his own resources. We take it or granted that he holds some post in a paper-mill. It is hardly to be expected that his employers would permit him to "poke h s nose" into every department in the mill for the purpose of gaining information. If this would be permitted (which is extremely improbable not to say unreasonable) no one mill will afford a sufficient object-lesson for the purpose of his studies. He is therefore thrown back on what literature he can obtain. He would require to save up his money for a considerable time in order to purchase the books recommended for study in the syllabus of the City and Guilds of London Institute, the total cost of these books being about £11.*

The publication of Hofmann's Treatise was discontinued after a sixth number, and therefore only about a third has appeared. Also the student cannot now obtain copies of the "Practical Paper-maker," by Dunbar, and the "Art of Paper-making" (Kent and Co.), as both these books are now entirely out of print; it must not be forgotten also that the "Chemistry of Paper-making," by Griffith and Little, and also Dr. Arnot's Lectures, are out of print. The student is therefore severely handicapped, as out of eleven books recommended for reading, four are now out of print, and one is only partially issued. Special articles also referred to in the trade journals are for the most part out of print, and therefore impossible to obtain. Even assuming that the pupil has all the literature on the subject available, either in his own possession or at some institute, he must have guidance in his studies.

PAPER-MAKING LITERATURE.

The text-book literature is for the most part, empirical, it does not deal with the general principles involved in the manufacture of paper, it gives a general description of the various processes, receipts, and illustrations of plant, &c. General principles hold good for all time, but empirical knowledge becomes obsolete in proportion as the industry advances. Many of the text-books on paper-making are old, and consequently out of date. The student who studies these may be unconsciously acquiring knowledge of what was done twenty or thirty years ago, instead of what is being done at the present day. Of course we cannot do more than make use of the literature that we have at our disposal, but those who are attempting to educate students should warn them of the difficulties with which they have to contend, and should direct and advise them in their studies, so as to save them unnecessary labour.

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* City and Guilds of London Institute. Programme of Technical Examinations, page 57.

Although text-book knowledge is very useful in its way, and very much to be encouraged, it will never make a man a good paper-maker; the ordinary text-book is more to be desired as a book of reference or a book at the elbow than a book to be committed to memory. That which comes to the memory should savour more of practical experience than of text-book knowledge.

From an educational standpoint, a knowledge of the *general principles* involved is much to be desired; this can be acquired in a measure by careful study of the history of paper manufacture. History reveals a gradual evolution since the introduction of the Fourdrinier machine. This is itself a valuable object-lesson demonstrating the unfolding of general principles. History also lends additional interest, and will often stimulate reading as well as enquiry. The reasons for the abandonment of one appliance in favour of another, and the effect of such a change on the improvement or otherwise of the product under treatment, and also upon economies of production, if followed in all its stages, reveals to us in the truest light, the scientific aspect of paper-making. Such studies are to be recommended for advanced students, and will be found most fascinating, besides being of real practical value, and encouraging scientific methods. One cannot over-estimate the importance of following step by step the *improvements* that have been effected from time to time in paper manufacture, their cause and effect, and why we have held to certain things, and why we have abandoned others.

TECHNICAL EDUCATION FROM THE WORKMAN'S POINT OF VIEW.

Let us now regard the question of education from the working man's point of view. Mr. Davis says (see above), "It is quite evident that the ordinary working man is not dependent in any way for the excellence of his work upon any scientific knowledge he may possess. It would not be fair to say that the possession of any scientific knowledge on his part would be a disqualification for his work but in all ordinary cases he would be just as well without it." However true this may be in some chemical industries I do not think it is true of paper-making. It is important that the working man should have an intellectual grasp of the general principles involved in the particular work he has to perform (which is only another way of saying that he should have scientific knowledge of his work), however limited in scope that work may be. In the case of paper making, which perhaps is a peculiar one, he should have more than this, for the simple reason that each process is dependent upon its predecessor and influences that which is to follow. The working man, therefore, in order that he may do his work well and intelligently, should have some scientific knowledge of the other branches of the work which influence his own or are influenced by his own. I am sure many practical paper-makers are fully alive to this.

It is said that paper is made in the rag house, this implies that the preliminary treatment of the raw material before it receives its real chemical and mechanical treatment, affects the whole of the subsequent operations.* And yet, how little the foreman of a rag house, to say nothing of those under him, knows of the after processes. Many of these workpeople, and undoubtedly with good reason, have not been permitted to walk through the other departments of the paper-mill. The same may be said of the "boiling," and perhaps with greater force of the "beating" departments. The beaterman, in my opinion, should possess a considerable knowledge of the processes to which the stuff is submitted, prior to the beating, and also (which is perhaps more important) a knowledge of the influence which some slight change in the beating will produce in the behaviour of the stuff on the machine, and its effect upon the qualities of the finished paper.

I claim also, from another standpoint, that all workmen should be able to avail themselves of technical instruction. In order to appreciate their claims to technical education, let us endeavour to place ourselves in their positions. Undoubtedly workmen are ambitious of improving their positions. The boy comes to a paper-mill and is put into some irresponsible position where he has to do little else than manual labour. As time goes on, and as opportunities present themselves, he is given a "rise" and put in a better position. He is drafted, perhaps, from one department to another, and he gradually takes a more responsible position. He may in the course of his multifarious duties have occupied every position in a paper-mill. It is important that he should have the opportunity from the very commencement, not only in his own interest but also in the interest of his employers, of obtaining a more intellectual grasp of the work he has to perform than he can gather from mere observation in the mill itself. Such knowledge must tend towards efficiency, it must give additional interest to work, and also it must assist a man to qualify himself for a better position.

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* The same remark is often applied to the "beating."

EDUCATION BY TRADITION AND GEOGRAPHICAL ISOLATION.

In former days knowledge was acquired by the old system of apprenticeship. The accumulative experience in many mills must have been great. This knowledge was handed down by tradition from one generation to another. Men, in order to maintain their positions perhaps after they were disqualified through age or want of energy from carrying out their duties efficiently, would refuse to impart the knowledge they possessed to those under them. The result has been over and over again in many industries, and in many mills, that this unwritten knowledge has died with the individual and has to be re-acquired by some means or other.

There is also another barrier. Paper-mills are distributed in various parts of the country, often in inaccessible and isolated places, from a geographical point of view, therefore, there are barriers to united action. A paper-maker often had little or no knowledge of what his next-door neighbour was doing. His instructions were often verbal, and there was no written literature of the mill. The valuable knowledge gained after many years of experience might easily become extinct on the death of one of the members of the firm, or perhaps on a change of management. It must not be forgotten that experience is not inherited, but has to be acquired.

What militated not many years ago against any possible chance of educational advancement or perhaps industrial progress was the conservatism and isolation, and sometimes perhaps, the jealousies of the paper-makers in different parts of the country. This state of affairs, from the industrial point of view, has for the most part been remedied. Rapid advancement, keen competition, and change of methods, have wiped out all this, and the keen competition which now assails all members of the trade, compels them to look for some united action to enable them to maintain their individual, as well as their national supremacy.

THE NECESSITY FOR TEACHING THE "PRACTICE."

Sir Philip Magnus in his paper on the "Theory and Practice of Trade Teaching," refers to the interpretation put upon the following words in the Technical Instruction Act,—"Shall not include teaching the practice of any trade or industry or employment."* He points out how these words have received very liberal interpretation. It is difficult to conceive how any trade or industry can be taught to any great advantage, unless the *practice* of the trade is taught at the same time. There is a good deal to be said on this point in relation to paper-making. The Act appears to throw the onus of teaching the *practice* of the industry upon the manufactures themselves. It must be conceded that indiscriminate teaching is likely to be productive of as little good as indiscriminate charity. Like everything else, it requires to be properly organised. It is impossible, for reasons above stated, for the average student who desires to make a study of the general principles of paper-making to obtain a sufficient diversity of practice, or of knowledge, in the capacity in which he works in a paper-mill. His technical knowledge will of necessity become limited unless the practice of the art can in some way be demonstrated outside his individual work. On the other hand, the paper-makers, as individuals, cannot resolve themselves into educational bodies.

TECHNICAL EQUIPMENT.

To overcome these difficulties, the Municipal School of Technology, Manchester, are setting a most excellent example by the erection, at a great outlay, of an installation of paper-making appliances on a small scale, by means of which the various processes of paper manufacture can be demonstrated to paper-mill workers. I am much indebted to Mr. J. H. Reynolds, Principal of the Municipal School of Technology, Manchester, for his courtesy in supplying me with details of the equipment. The plant is now in process of instalment, and when complete will comprise the following:—

Equipment of Paper-testing Laboratory.—Microscopes, micro-photographic outfit, tearing machines, micrometers for measuring the thickness of papers, stoves for ascertaining the moisture in wood pulp, apparatus for ascertaining the resistance to folding and crushing, paper balances, ash balances, and numerous other appliances.

Paper-making Plant.—Rotary spherical boiler, breaker, beater, stuff chest, sand-tables, strainers, Fourdrinier machine (to make paper 24 in. wide, wet end), two wet presses, two batteries of drying cylinders, smoothing calendar, slitter knives, reeling apparatus, re-reeling apparatus, sheet cutter, ordinary and friction calender, embossing calender.

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* "International Congress on Technical Education," p. 27.

"*Hand-made*" *Plant.*—Vat, couching arrangement, special drying arrangement, spindle press, plate glazing calender.

As far as I can gather from all sources, I shall be right in saying that the above equipment is quite unique, and it is to be hoped that the Committee's heavy expenditure will receive the support that it deserves from the paper trade in all parts of this country. I am informed that Mr. Julius Hübner, F.C.S., is the head of the paper department; he instituted the technical classes in connection with paper-making about nine years ago. I feel it only right to say that the trade is much indebted to Mr. Hübner for the enterprise and public spirit he has displayed. It was, I believe, due in a large measure to his support that the Municipal School of Technology decided to take the bold step, originally suggested by Mr. Robert Marx, of erecting model paper-making plant for educational purposes.

"EDUCATION INTÉGRALE."

In order that any real and substantial progress can be made in the technical education of paper-making, it is necessary that *practice* and *science* should go hand in hand. To read about a process, or even to be lectured to about a process by a practical paper-maker, could not give the same acquaintance as a combination of such teaching with the actual working of the process itself. On the other hand, seeing a process carried out, or even conducting a process for oneself, on a commercial scale, does not necessarily convey anything like a full knowledge, unless the scientific principles are, at the same time, fully enunciated. This is powerfully urged by Krokoptin, who condemns the arbitrary division of society into brain workers and manual workers, and advocates the system known as *Education intégrale*, in which both brain work and hand work are cultivated side by side. The importance of this mode of procedure as far as an industry will permit it, cannot be over estimated.*

It should be borne in mind that since the introduction of the Fourdrinier machine, the paper-maker is no longer the man who makes paper, in the literal sense of the word but rather one who understands how to make it. The "hand" cannot be used in conjunction with the "head," to the extent to which it can be in many other industries, but notwithstanding, the "hand" should be used to the extent of being able to operate any machine used in the process of paper manufacture, in addition to assist the understanding of diagrams and plans setting forth the full details of the machine, and education should extend to a full knowledge of the general principles of its working.

It is to be hoped that the enterprise displayed by the Municipal School of Technology at Manchester will be productive of much good in this direction. It is quite feasible that a great deal of useful educational work could be done with a small paper-making machine. It is, perhaps, too much to expect that workmen would become practical machine men by merely familiarising themselves with the working of a small machine, but they could certainly rapidly acquaint themselves with the general principles of the machine and the influence of the different factors which control the properties of the web of paper far more quickly by such means than they could ever hope to do by acting as an assistant to a machine man on a big machine. With such a small machine the thickness, the shake, the suction, the drying, and the pressure of the rolls, the temperature of the stuff and all such details could be controlled and rapidly changed at will, and the influence of all the changes could be studied in their effect upon the finished paper. A small machine might also be used for any class of material. An immense amount of useful information should be imparted by such means, which might prove of the greatest industrial as well as educational value.

A small machine, such as that being erected at the Municipal School of Technology, can hardly be expected to do the work exactly in the same manner as a large machine would. I contend that this is not necessary for educational purposes. We all know that there is a difference between a chemical reaction on a few grains in the laboratory, and the same reaction, when carried on on a commercial scale, but there is, nevertheless, a direct relationship between large and small operations, which can be absolutely accounted for. It is conceivable, therefore, that a relationship can easily be established between operations of a small paper machine and those of a large paper machine, so that valuable and practical deductions can be arrived at even in the event of the small machine affecting the stuff somewhat differently. The Municipal School of Technology, Manchester, and also the engineers, Messrs. Hemmer Brothers, are to be congratulated on this very bold experiment, the results of which will undoutedly be looked forward to with great interest by members of the paper trade. Should it succeed I think we should be compelled to modify our views as to the possible scope of technical instruction from a paper-maker's standpoint.

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* "Fields, Factories and Workshops," by P. Krokoptin, Swan, Sonnenschein and Co., Ltd.

It is encouraging to know that the technological examinations are becoming more and more practical every year; this must help to make the teaching more practical also. The responsibility of the examiners is very great because the character of the questions which are set will, in a large measure, influence the character of the teaching, as a large bulk of those who go in for technical education do so with the object of passing the City and Guilds' examination. It is very gratifying to see so many more students entering for the examination, but it is to be hoped a far larger number will enter in the near future.

The student has, perhaps, at present, four courses open to him, whereby he may acquire a knowledge of paper-making.

1st. By his actual work in the paper-mill.
2nd. By reading text-books.
3rd. By his attending classes.
4th. By correspondence teaching.

The limitations to the first of these have already been discussed.

TECHNICAL ARTICLES, LECTURES, AND EXAMINATIONS.

Text-book knowledge is valuable in its way, it is extremely useful in conjunction with practical work, but something more is wanting than text-book knowledge to supplement the ordinary practice in the mill. To supplement text-book literature, I would suggest that much good might be done by the publication from time to time of technical articles, dealing rather with general principles than with bare statements or descriptions of the processes, but whatever direction these articles take, it is important that we should keep them up to date. It is important that the mill worker should have the opportunity of close contact with those who are endeavouring to teach him, hence the necessity for lectures in all the most important centres.

Technical education will be of little or no service unless it keeps abreast of the times. It is no good teaching what has been, but what is and is to be. It will be no good employing academic teachers. Practical men of good standing alive to all recent improvements and in close touch with the industry which they profess to teach, will be required—men who can acquire and assimilate all the most recent improvements, and not men who teach the same thing year after year with little regard to changes that are taking place. What benefits shall we derive from men who go about the country lecturing on technical subjects, the whole of their knowledge of which is derived from text-books? In order to impart technical skill and knowledge a man must be what he wishes his pupils to become. An intelligent pupil, if he desires to, can assimilate knowledge from a text-book without the aid of a public exponent. Instructors are wanted for the purpose of imparting that intimate knowledge that cannot be derived from text-books.

Fifteen years ago, on good authority, we are informed that the attitude of the workman towards education, was positively hostile. Five years ago we were told that this feeling had almost disappeared. To-day, we find the National Union of Paper Mill Workers, or the Amalgamated Society of Paper Makers, meeting and discussing the subject of technical education, and even urging the necessity for it as a means of fighting foreign competition. The men themselves have not only lived down their prejudices, but are now crying out for technical instruction.

At a meeting of the Trades Union held in 1894, a fear was expressed that the technical education would tend to overstock the trade with working men, and consequently bring down the wages and increasing the unemployed. It has been considered necessary by many to stipulate, that only those engaged in the trade should receive instruction. I am very much in sympathy with those who consider it unfair on *bonâ-fide* paper-mill works to give instruction to outsiders, and that the instruction should be limited only to *bonâ-fide* paper-mill workers. This view has been expressed by members of different trades, and not without good reasons. If the examinations could be made an absolute test of practical experience and knowledge it might not be necessary or, perhaps, desirable to make this stipulation. It has, however, under existing circumstances not proved possible to make the examinations a real practical test.

As the result of the examinations, Mr. Slingo* informs us that "One city clerk was, in his year, the prize carpenter of the United Kingdom; another took the prize in the electric lighting; another the prize in the electrical instrument making; another in tools; and another, who had never been out of London for more than a week or two at a time, obtained a certificate qualifying him as a teacher for agriculture." Under such circumstances, and until examinations can be made an absolute measure of practical knowledge and experience, it would be only fair to prohibit all outsiders from competing. It is very encouraging, therefore, to know that the technological examinations are becoming more practical year by year, but it is impossible to urge upon the examiners too strongly the necessity of making them more so, and to be satisfied with nothing less than an examination which shall be an absolute measure of practical experience.

Correspondence Tuition.

It has been urged that correspondence tuition tends to discourage class teaching, which is considered far more valuable, and therefore, correspondence teaching should not be resorted to. I have conducted a correspondence class in the paper trade, and have found that the greatest number of students in any one locality, who have availed themselves of the correspondence tuition, have at the same time been attending lectures and classes conducted privately by their employers. It does not appear that correspondence tuition will in any way interfere with the lecture attendance, but it would appear rather that one will assist the other. There are many things to be said in favour of correspondence tuition; for instance, there are many difficulties to be contended with in classes, which do not occur in a correspondence tuition. The classes are few and far between and not accessible to many, whereas, correspondence teaching is equally accessible to students in all parts of the country. Correspondence tuition is perhaps a misnomer, my ambitition has rather been to help and guide mill workers by means of test questions. I have endeavoured to set them leading questions of a practical nature, and on receipt of their answers have published through the medium of "Paper and Pulp," my remarks on each answer. Each worker has the advantage of reading my remarks on all the answers. In many cases I have quoted from the answer, and some cases, where the answers are very good, have published them in full to encourage the workers as much as I can. Whatever objections may be raised against this by the City and Guilds of London Institute, the result is certainly very encouraging. All the workers, I think, without exception, have improved in their answers; they are getting to know how to tackle questions, and how to express themselves better. The average paper-mill worker, however thorough his practical knowledge may be, requires practice in constructing his answer before he enters for the examination. Apart from actual aid for examination purposes, "test questions" might have a wider and more important scope—they stimulate enquiry. The worker has the questions before him, and he goes about his every day work in the mill and thinks them over. His own work may have some bearing on the question set him; they are not sprung upon him all of a sudden, as at an examination. He has plenty of time to think them over before he need answer them.

I do not wish it to be thought that correspondence tuition should take the place of classes and lectures. I think that probably the first aim should be to establish classes and lectures in important centres, but inasmuch as classes and lectures, however well they may be organised and attended, can only benefit a limited number, whereas correspondence tuition, or "test questions," somewhat on the limits above indicated can be made to reach everybody, I think they are much to be encouraged.

The Hertfordshire County Council did me the honour of asking me to lecture before the Dickinson Institute, and I delivered a course of six lectures last autumn. I was much struck with the enthusiasm displayed by the work-people, about 80 of whom attended. The Hertfordshire County Council have perhaps shown as much enterprise as any centre; they have again enlisted the services of Mr. J. T. Ainslie Walker in preparing students attending the Dickinson Institute for the forthcoming examinations. The trade in general in and around London are indebted to Mr. John Wilson, F.C.S., for having started a class at the Battersea Institute. Last session Mr. Wilson delivered a course of lectures on the "Chemistry of Paper Making," and this year he has secured the services of Mr. E. J. H. Stallybrass (Assistant Examiner of paper in H.M. Stationery Office.) The course this session is chiefly devoted to paper testing. The course has started well with thirty-five entries, the practical work being the great inducement, especially as the course is quite novel in the London district. Other classes and courses are being held, but space will not permit me to go further into these details.

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* "The True Basis of Technical Education," by William Slingo, before the International Congress.

EDUCATION ABROAD.

I am indebted to Mr. Robert Marx for the following information in regard to work that is being done on the continent.

As far as the technical education of workmen in Germany is concerned it may be stated that there is no institute for paper-mill workers. There are of course places where mill foremen can obtain the requisite knowledge, and others for fitters, but, generally speaking, the mill hands have to learn everything connected with their work in the paper-mill itself. Furthermore there are no technical schools provided for paper-makers.

Some time ago Professor Kirchner, of Chemnitz, gave several lectures to students, but was compelled to abandon them on account of insufficient support. There is, however, a school for paper-makers in Vienna attached to the Royal Technical Museum, under the control of Mr. H. Schultze. Some of the universities and technical institutions in Germany give regular courses and lectures on paper-making, but all these are chiefly intended for paper-making engineers. As far as I can ascertain very little is being done in the United States to further technical education for paper-makers.

THE VALUE OF RESEARCH.

As a part of the educational scheme it is impossible to over-rate the importance of chemical research. Research work may be divided under two headings: (1) Industrial Research and (2) Pure Research. The very basis of our national advancement and prosperity must of necessity be largely dependent upon the careful and systematic prosecution of chemical research. There are a lot of questions pertaining to the paper trade, many of them apparently small but important details, only awaiting exhaustive and systematic study. In any adequate scheme for technical education, those who pose as instructors and demonstrators should have an intimate knowledge of what they desire to teach, but without research this cannot be done. I venture to think, therefore, that any institution or technical school that takes in hand instruction in paper-making, should recognise the necessity of students applying themselves systematically to technical research.

There is a kind of research which is outside the ken of the majority of workers, but which is nevertheless of great importance if we are to safeguard our interests in the future. I speak of pure research. In the prosecution of pure research the chemist, more often than not, has no immediate industrial object in view, but if we read the history of modern progress correctly we cannot fail to recognise that many of the most important economic changes have been the direct outcome of pure research. And so it must be, but in a greater degree, in the near future. Although there are several workers on the Continent, Messrs. Cross and Bevan stand practically alone in this country in the prosecution of pure research in connection with the paper industry.

Our war of the future must of necessity be an industrial war. There will be little good in waging this singly and individually. It calls for the most perfect and efficient equipment, and for united action. The trade as a whole should, I venture to think, recognise the necessity of furthering to the utmost technical education, and seriously consider the best means of effecting the desired end.

To sum up, I venture to say that what is needed is a central Paper Makers' Institute to undertake the prosecution of industrial and pure research, as well as the technical education of all students. It will be necessary, of course, to have the use of a thorough equipment, such as the Municipal School of Technology are now installing. This institute should organise classes, lectures wherever possible, and a course of correspondence tuition. The intelligence department should jealously watch publications of all sorts bearing on paper-making in all parts of the world, and should issue publications to all paper-makers who support the Institute. They should make it their chief aim to render men more efficient in their daily duties, and to qualify them for better posts. They should make it their aim also to qualify those who desire it, for the City and Guilds of London Institute, and to urge upon the institute the necessity of modelling the examinations so as to make them in every way a thorough test of practical knowledge and experience. When this can be accomplished a certificate from the City and Guilds of London Institute will serve to qualify a man for a better position, and what is of more importance, perhaps, paper-makers might insist upon their workpeople, at any rate those in responsible positions, taking certificates.

Our paper industry, containing as it does many practical progressive men, alive to their own interests, is still *lacking* in the department of technical education, and lacking possibly because private enterprise alone cannot promote it sufficiently. State aid may do some good, but the initiative must come from the members of the trade, and whatever shape the movement takes, it must be the outcome of united action on the part of those who are to reap the benefit that is bound to accrue.

DISCUSSION.

Mr. CROSS considered that the paper was philosophic and temperate, and that Mr. Beadle justified his pronouncement by suggesting something practical. He was particularly happy when he spoke of the paper trade as constitutionally unscientific. It might be said with truth, that this country was altogether constitutionally unscientific, especially in its industrial life. Every other civilised community in the world had a system of measurement and notation which encouraged industrial life, but in this country our system was barbarous. As an Englishman he was very proud of the pound sterling, which needed no revision, as fortunately it was the standard of the world's commerce. There was also another measurement of which Englishmen were proud, the Greenwich meridian. But there his glory in the foundations of industial life ended. Quite a century ago the French people had the intelligence to adopt the metric system. There was no need to be superstitious about the number 10, because in many departments of life 12 was a more useful basis than 10. Every French child was unconsciously educated in the idea of related quantities. It knew that a ton of water was a cubic metre, or that a cubic metre was a ton. An Englishman, however, would be taken aback if asked the volume of a ton of water. Chemists could not exist without the decimal system. The reason why this country was constitutionally unscientific was because of its refusal to give that essential metrical training which came from handling the fundamental matters of industrial life in terms of related quantities. Speaking more directly on the subject of the paper, Mr. Cross thought the barrenness of the technical literature in the paper industry was to be deplored. There was a great want of a really high-class journal, conducted on the lines of *Engineering* and *The Engineer*, and any movement which would strengthen the present technical press, would do very much to add to the prestige of the paper trade. He believed paper-makers paid very little attention to what appeared in their technical journals. The suggestion for a Paper-makers' Institute would certainly be a difficult one to carry out. In this country it was not possible to depend on organised instruction or State aid, as was done by continental nations. But while we were constitutionally unscientific, we were constitutionally enterprising, personal enterprise and adventure taking the place in this country of the Government-supported institutions of foreign countries. He considered the action of Manchester in starting a well-equipped paper-making laboratory for the purpose of research would lead to important results, and he expressed the hope that the institution would not be exploited for individual and private purposes, but would be utilised for the interest of the trade as a whole. Every well equipped paper-mill in this country by adopting a rather higher standard of life amongst its workers, by paying greater attention to foreign publications, by maintaining an intelligence department, and by systematising the whole of the operations of its own mill—putting everything on record—thus bringing the technology of the industry into its own mill, would carry out Mr. Clayton Beadle's suggestion in a thoroughly English manner. The method by which England has reached its present position was hard work and plenty of nerve, and by adding a thorough scientific industrial training, English industries, paper-making included, would hold their own in the struggle for existence which marked the present day.

Professor J. HÜBNER had had experience of teaching classes in the technology of paper-making, and considered the principal shortcoming of the students attending those classes was owing to the deficiencies in their general education. Most of such students had little knowledge of mathematics, chemistry, or mechanics, and in paper-making it was essential that a student should have a knowledge of chemistry and mechanical engineering, because only on such a foundation was it possible to teach the technology of paper-making effectively. As Mr. Beadle had remarked, there were very few institutes on the Continent—in fact, in Germany there were none—where the working man was educated. The German technical schools, and especially the German technical high schools, such as the one in Charlottenberg, were only open to youths who were at least 18 years of age, and who had passed through a full course at a grammar school. In the municipal technical school in Manchester, it was not intended to educate the working man, but to educate the coming leaders of the industry—foremen, managers, or owners of mills. He was well aware that the plant was an experimental one, but German technical schools had shown for the last 15 or 20 years, that such experimental plants had worked very well and had done a great deal of good for German industry. There were slight differences, no doubt, between the work done on a small machine, and work done on a large machine, but it was possible to come to certain conclusions by comparing the work and draw therefrom some useful data. No doubt the most complete education would be afforded in a school fitted up as a proper paper-mill, but that mill would have to make all the different kinds of paper, or the student would only obtain a one-sided experience. The Russians excelled in their beautiful water-marks, and especially in the papers made in the Imperial mill in St. Petersburg. The system of education in that city was the most complete of any country. The Government conducted the school in the paper-mill itself, and the boys chosen had to undergo three years training, which included a certain number of hours each day spent in the Imperial paper-mill itself. They learnt the whole process. Young men educated in that way were only educated for the paper-mill, and not for any outside industry. As we were not able to institute a system of education in that way, it would be of some assistance to train the student by means of a small experimental plant. It was beyond doubt that research work could be done in a laboratory to a certain extent, but for practical use it was absolutely necessary to work with the paper-machine itself.

Colonel ALLAN CUNNINGHAM wished to say something upon the subject of the inefficiency of written examinations. Such examinations were naturally competitive, and tended to take the form of literary work. Although it was absurd that a City clerk should get the prize for agriculture or chemical industry, a man accustomed to reading and writing, and who had attended a few classes and visited a few factories, was in a better position in a written examination than the real craftsman, who was heavily handicapped by the great difficulty he had in expressing himself in good English, which meant a great deal in a written examination. With regard to material used in paper-making, Colonel Cunningham hoped that paper-makers would turn their attention to such materials as were not badly wanted for some other industry. He was sorry to see that wood pulp was becoming a very large item in paper-making. Wood was of slow growth, and could not be re-placed, and unless a forest was properly re-planted, irreparable injury was done to the country. The loss of forests in the North-West of India had led to a total change of climate, the garden of India being turned into a desert. In the hill country it was still worse, because the loss of the forests did not merely unfavourably change the climate, but led to the loss of the soil, which was washed away.

The CHAIRMAN, in tendering the thanks of the Society to Mr. Clayton Beadle for his valuable paper, observed that it was very instructive and suggestive, and could not fail to be of practical use. He considered that the education of the paper-maker could be carried out in a practical way, and at little cost, satisfying the workpeople and the paper-makers at the same time. The institution should be made partly self-supporting, the mill being utilised for research and experimental work. To discover how to make paper in the cheapest possible way, how to make the best paper, and how to carry out the various necessary operations, meant that the mill would have to be equipped with all machinery, complete as a paper-mill from beginning to end, capable of producing paper under all conditions, even including wood pulp, to which Col. Cunningham seemed to have a great objection. But a large quantity of wood was being used nowadays, and was likely to be used, at any rate for the next generation. Wood fibre was eminently adapted for the manufacture of paper, and he believed it was capable of being used with other materials, such as a soluble cellulose, by which a cloth-like substance could be produced, useful not only for writing upon, but for clothes and other things. A technical school such as that described by Mr. Clayton Beadle would be of great advantage and would do away with any jealousies which might exist amongst manufacturers as to information being given to one mill and not to another. Such an instance, instead of drawing information from paper-makers, would be the centre from which information would be derived by every mill in the country, and thus trade would be greatly benefited. The necessity for a thorough education was very great, especially in regard to foremen and managers, because if these were not afforded a real practical knowledge of their trade this country would have to retire into the back ground as far as paper-making was concerned. With regard to fibre, he thought it could not be denied that there was great need of a new fibre in the industry, and at present wood appeared to be the only available supply, and the abundant forests in America and Canada and the North of Europe were capable of meeting the need of the industry for some years to come. It was well-known that even when people were so careless as to take no trouble in re-planting, Nature was so generous that she planted the trees herself.

Mr. CLAYTON BEADLE, in reply, said that if the paper exerted enough influence to bring about improvement in the methods of education, he should be fully rewarded for the trouble he had taken in writing it. On the subject of making paper without wood, he expressed the opinion that paper could be no more made without wood, than pottery could be made without clay, because there was no other fibre on the face of the earth so abundant and so cheap as that derived from wood. He expressed himself as much gratified with the Chairman's remarks on the use of a model paper mill for educational purposes, as Captain Partington's opinions, as a practical paper manufacturer, would go a long way towards creating a feeling in the minds of paper-makers throughout the world as to the advisability of taking some such steps.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

NUTMEGS AND MACE.

Nutmegs are the kernels of the dried seeds of a handsome, bushy, evergreen tree, known as *Myristica fragrans*, Houttuyn (N.O. Myristicaceæ), which grows wild in the Moluccas and Banda Islands, besides being largely cultivated in various parts of the East and West Indies, the nutmegs of commerce being chiefly exported from the Malay Archipelago to Amsterdam and London.

Nutmegs and mace were imported from India at an early date by the Arabians, who probably first became acquainted with them through the Persians. It also appears probable that nutmegs were known at Constantinople about the year 540, while both nutmegs and mace were being imported at Aden in the middle of the twelfth century, and were well known in Northern Europe by the end of that century. The Portuguese discovered the nutmeg tree in the Banda Islands in 1512, and the Dutch, who subsequently came into possession of those islands, attempted to secure their monopoly of the nutmeg trade, by limiting the districts in which the trees might be cultivated. About 1800, however, the culture of the nutmeg was introduced into Bencoolen, Penang, and elsewhere by the English, during their occupation of the Spice Islands.

The nutmeg tree attains a height of twelve to fifteen metres, and is diœcious, the male and female flowers being on separate plants. The tree comes into bearing in its ninth year, and is said to continue fruitful for forty to sixty years, producing as many as two thousand fruits annually. The fruit is a fleshy fruit, like a drupe, about five centimetres in diameter, and not unlike a small round pear in shape. A distinct furrow passes round the fruit in a longitudinal direction, and as ripening proceeds, the yellow fleshy pericarp of the fructified ovary becomes dry and leathery, then splits into two parts where the furrow appears, disclosing a single dark brown, shining, ovate seed, enveloped in a fine crimson, fleshy, leafy mantle or arillus, which, when detached and dried, becomes reddish-yellow and constitutes the mace of commerce. The nutmeg tree yields three or more crops annually, and may bear all the year round. The fruit is gathered by means of a hook attached to a long stick, the dried pericarps being subsequently detached, the mace removed, and the seeds carefully dried. For that purpose they are placed on frames in a brick building and exposed to the gentle heat of a smouldering fire, with arrangements for a proper circulation of air. The drying operation lasts for two months, during which time the nutmegs are turned every second or third day. When properly dried, the kernel rattles in the thin dark brown shell (testa) when shaken, and the shells are then broken with a wooden mallet, after which the nutmegs are picked out and sorted. Nutmegs are sometimes dressed with lime, but Penang nutmegs are always exported in the natural state. The treatment with lime was originally adopted by the Dutch, with the object of preventing germination of the seeds after exportation, but it tends to spoil the nutmegs, and is said to be unnecessary to protect them against the attacks of insects. Broken and imperfect kernels are usually reserved for the production of the volatile and expressed oils which they contain.

As seen in commerce, nutmegs rarely exceed twenty-five millimetres in length, and they are rather less than that in thickness, being oval, rounded, or broadly and bluntly ovoid in shape. Nutmegs which have not been dressed with lime are greyish-brown in colour. The surface is marked with shallow furrows, which present the appearance of network (reticulated), and, when examined with a powerful lens, it appears finely pitted, in addition to being marked with minute reddish points, dark reddish-brown lines, and irregularly elongated spots. A transverse section of a nutmeg has a waxy, marbled appearance, the latter being caused by the reddish-brown inner seed coat or tegmen penetrating into the lighter-coloured albumen in long narrow strips or veins. The embryo can be detected at the base of the albumen, close to a scar—the hilum —indicating the point where the seed was formerly attached by a cord (funiculus) to the placenta in the fertilised and developed ovary. The hilum lies in a small circular depression surrounded by a raised ring, and a furrow on one side of the nutmeg indicates the course of the raphe, a cord or ridge of fibro-vascular tissue extending from the base to the apex, terminating in the chalaza or point where the kernel joins the integuments of the seed.

Mace, as already stated, consists of the dried arillus of the nutmeg. It originates in the thickening of the funiculus, extending to the outer integument of the seed near the opening (exostome) in the testa which occurs at the apex. As the arillus develops and surrounds the seed, it divides into branching lobes, impressions corresponding to which are marked on the dark-brown testa of the seed. Those impressions must not be confused with the depressed lines on the surface of the nutmeg, which are produced by the infolding of the tegmen, and correspond to branching fibro-vascular bundles near which the infoldings occur.

The seed kernel and arillus both possess a strong aromatic odour and taste, due to the presence of volatile and fixed oils. Nutmegs yield from 8 to 15 per cent. of volatile oil, and dried mace from 4 to 15 per cent. of a very similar but more fragrant oil. The expressed oil or fat commonly known as "oil of mace" is also present in both nutmegs and mace, the former containing from 25 to 30 per cent. or more. Nutmegs possess aromatic, stimulant, and carminative properties, and act as a narcotic poison in large doses. They are only used in medicine for flavouring or covering the taste of other medicines, the official spirit, which is prepared by dissolving the volatile oil of nutmeg in strong alcohol, being chiefly employed for that purpose. The volatile and fixed oils have also been used in chronic rheumatism, and in the preparation of lotions for the hair. The chief use, however, of both nutmegs and mace is as condiments.

Other species of *Myristica* produce seeds which are distinguished from those of *M. fragrans* by their shape, being usually longer, narrower, and more or less destitute of aroma. The seed of *M. malabarica*, (Lamarck), a native of India, is used both medicinally and as a spice in certain parts of India, the fixed oil it contains being made into an ointment for indolent ulcers, &c., while the kernel is taken internally as a remedy for headache and as an aphrodisiac. The fruit of the tree is an oblong, tawny, hairy fruit, from six to eight centimetres long, with an elongated seed from three to five centimetres in length, and enveloped by a dark brownish-red arillus, the lobes of which are longer and thinner than those of true mace, besides being twisted and folded into a cone at the top. The kernel has the same ruminated structure as the nutmeg, but has only a fruity odour, with scarcely any aroma. The dried arillus, which has been sold under the name of "Bombay mace," is also deficient in odour and flavour.—*Pharmaceutical Journal.*

WEST INDIAN SUGAR INDUSTRY.

The cane sugar industry of the West Indies, as is well known, has been in a bad way for years past, owing to its being unable to compete with the continental beet sugar, and due partly to the machinery in use in the majority of the factories, being of a very crude and uneconomical type; but since the termination of the American-Spanish War, a good deal of attention has been given to this industry by American capitalists, and many orders have been executed for more up-to-date machinery for several of the West Indian Islands and Mexico, while many extensions and new factories are at present under way.

Among those islands in which new factories are now in course of erection, is Cuba, the largest of the West Indian group, and an island possessing enormous resources, although only 8 per cent. of the sugar-producing land was under cultivation to produce the last sugar crop, which amounted to 600,000 tons. Several companies have, however, lately been formed with the object of developing the sugar industry of Cuba, one company, viz., the Cuba Sugar and Land Company, having just contracted for the planting with cane of one million acres of land, and intending to erect a mill of its own for crushing, instead of selling it to neighbouring factories, as has been the custom.

What will, at all events, be one of the largest installations—if not the largest—ever set down in a sugar-producing country at one time is that at present undergoing erection at Puerto Padre, Cuba, for the Chappasa Sugar Company, of New York, this island having been selected for the placing of this large factory on account of the excellent nature of the soil for growing sugar cane.

The plantation acquired by the company comprises about 100 square miles of the finest sugar lands in Cuba.

The greater portion of the machinery, unfortunately for British sugar machinery engineers, has been constructed in the States, the order for the crystallising plant only having come to this country. Watson, Laidlaw and Co., Glasgow, having been fortunate enough to secure the contract, on account of the excellent work they turn out in this particular line, of which they make a specaility, and which they have supplied now to all parts of the world where sugar is grown. Out of the 64,000 acres which comprise the plantation at Puerto Padre, 10,000 acres only have been planted for the first season, this amount being estimated to produce 300,000 tons of cane, 30 tons being allowed per acre, although a maximum of 50 tons per acre is reckoned for Cuba, the crushing plant being of a size which will enable the above-named amount to be cleared in four months.

The crushing plant consists of two sets of nine-roller mills, or six three-roller mills in all, each being fitted with Marshall's cane crusher. The rollers are 34in. diameter by 7ft. long, and it will, no doubt, be interesting to sugar machinery engineers in this country to hear that the rollers are fitted with hollow-steel shafts, which were made at Bethlehem, Pa. For the driving of these mills six Corliss engines—two of 150 horse-power, two of 250 horse-power, and two of 350 horse-power—have been built, the complete crushing plant being supplied by the Whitney Iron-works, New Orleans, at a cost of about 150,000 dols.

For the clarifying of the juice the Deming system of high-pressure clarification is to be used, the clarifying plant being also made at New Orleans by Mr. E. H. Deming, the inventor and patentee of this system.

To evaporate the cane juice after clarification two sets of 325,000-gallon triple effect "Lillie" evaporators are provided, and for the final boiling of the juice three vacuum pans, each 13ft. diameter; the multiple effects and vacuum pans have been constructed by the Sugar Apparatus Manufacturing Company, Philadelphia, of which Mr. Morris Lillie is president. On the boiling of the sugar to massecuite in the vacuum pans being completed, it is ready to go to the large crystallising plant made by Watson, Laidlaw and Co.

This plant consists of twenty crystallisators, 8ft. 3in. diameter and from 24ft. to 28ft. in length, constructed throughout of steel plates. The massecuite, which if run in by a man-door on top, is kept in motion by means of stirrers inside, which are actuated by worm gearing. Steam and syrup connections are also fitted, and on the sugar crystals being properly formed and ready for centrifugalling, a large valve on top is opened and the massecuite discharged up a pipe, which conveys it to the mixer over the centrifugals.

The installation of centrifugal machines is one of the largest, if not the very largest, made in this country, and was also constructed by Watson, Laidlaw and Co. The machines number twenty-four, and are of this firm's water-driven "Weston" type, having baskets 40in. in diameter, the baskets and mixers being supported on their patent steel framing. The water motors which drive the baskets are of the Pelton type, and are each fitted with two separate water jets, one or both being used, according to the grade of sugar being cured and the speed required to effect it. The water driving the motors is supplied by pumps at a high pressure to the main water over the mixers, from which a separate connection is taken to each motor, the discharged water again going to the pumps, thus undergoing a continual circulation.

The necessary power for driving the complete plant and the steam for boiling purposes is obtained from Babcock and Wilcox, 40-tube type boilers, having in all 6,000 horse-power, these boilers having been procured in New York. For the conveying of the canes from the fields to the factory, lines of light railway run in various directions, the company having several locomotives and numerous tracks for this purpose. In all probability large additions will be made to this plant at an early date for the working up of the remainder of the 64,000 acres.

There is probably a bright and prosperous future for Cuba, which is at the present moment practically totally undeveloped, and it is to be hoped that the sugar machinery engineers in this country will not let the opportunity pass, for which they have waited so long.—*The Engineer*.

TOBACCO CULTURE IN HAYTI.

Hayti, situated in nearly the same latitude as Cuba, will, it is said, soon rival it in its production of fine grades of tobacco. It has a more equable climate, free from cyclones and hurricanes, and a far more fertile soil, which has not been weakened by long continued cultivation. All that is needed is skilled cultivation and proper curing. It may be said that tobacco culture has now passed the experimental stage, and will, within a few years, become an important source of revenue to the Republic. The United States Minister, at Port-au-Prince, says that a new species has been produced by cross fertilization, called the "Diqueney"—after the place where it is grown—said to surpass, in many respects, the best Cuban grades. This species grows from five to seven feet high, and bears within a few inches from the ground, a large smooth leaf, 20 inches long by 15 inches wide, free from defects. The seed is sown in the latter part of July, in well irrigated beds, which are protected from the fierce rays of the sun, by light, raised covers. In September, the plants are transplanted into carefully prepared beds of rich dark, loamy soil, which are also kept plentifully supplied with water. Cutting takes place about three months after planting. Between the latter part of November and the middle of March, three cuttings are made; a fourth can be made, but the quality of the tobacco is not so good. The process of curing, upon which the value of tobacco depends, is as follows:—The tobacco, after being dried in the drying-house, is subjected to a sweating process of from three to four days, dependent upon the weather. The leaves are then stripped from the stems and assorted, after which they are left for one or two months. The tobacco, in bales, is then placed in a press, holding from 1,500 to 2,000 pounds, for fermentation, where it remains eight or more days, until it reaches a temperature of 136° Fahrenheit. It is then put in a second press, where it remains fifteen days, until it reaches the same temperature. This operation is repeated six times before it is placed in the last press, where, after being moistened with water, it remains a month. The tobacco is then arranged in large bales, and left for two months, when it is made into bales weighing 150 pounds, and stored in a dark room for six months.

AFRIDI WAX-CLOTH.

Mr. George Watt, the Reporter on Economic Products to the Government of India, has succeeded in inducing the Afridi wax-cloth workers to impart the secret of their craft, which has hitherto puzzled all inquirers into India industries. Afridi wax-cloth, a kind of raised coloured painting on cotton fabrics, has been made almost from time immemorial, and is a well-know product of certain workshops in Peshawar, Lahore, Calcutta, and Bombay; but until Mr. Watt set about his inquiries complete ignorance prevailed, outside the circle of artizans, as to the constitution of the medium employed. With the assistance of Mr. Roe, the Secretary to the Peshawar Municipality, Mr. Watt was able to ascertain that the medium, known as *roghan*, is a peculiar product of the safflower seed. The method of preparation, which is carried on entirely at Peshawar, is to boil the oil—expressed from the seeds by cold pressure—for twelve hours, and then throw the heated fluid into shallow pans of cold water. Under this treatment it swells up into a thick jelly-like substance, which is the *roghan* of commerce. Before being applied to the cloth it is mixed with some mineral colour and drawn out into fine threads on a pointed style, with which the pattern is traced. The operators, who are invariably Afridis, attain a very high degree of skill, and possess marked artistic abilities. The weight of Afridi wax-cloth—an Afridi woman's costume would turn the scale at over thirteen pounds—makes it unsuitable to articles of European dress; but the ever increasing demand for household drapings gave a ready outlet for the Afridi artizan's skill, to which he has readily adapted himself. Careful tests made in Calcutta also showed that as a water-proofing material, or as a material to be used in the manufacture of linoleum, *roghan* has a distinct claim to careful consideration, and is in some respects superior to linseed. Systematically exploited, there would appear to be a promising future before this industry.—*The Times of India.*

Correspondence.

IDENTIFICATION OF WOOD.

My attention has been drawn to remarks regarding me by Sir George Birdwood in the *Journal* of December 20th. Sir George states that in the paper read at a meeting of the Society on December 4th, Mr. Herbert Stone had sneered at scientific botanists, and that this "cheap sneer had been emphasized by me as chairman." I have once more read Mr. Stone's paper, and his subsequent remarks, and am unable to find any words which can justify the expression, "a cheap sneer at scientific botanists." Mr. Stone complains that botanical explorers often omit from their description of plants anything that is likely to be practically useful. This complaint is just, but it is not a sneer at scientific botanists.

Sir George further accuses me of having endorsed the heedless and unintelligent criticisms, to which Kew was subjected by some of those who spoke in the discussion on Mr. Stone's paper. The only one of the speakers who mentioned Kew, was Dr. Augustine Henry. During his twenty years' residence in China, Dr. Henry has steadily sent to Kew his magnificent collection of plants, which now form one of the chief sources of information regarding the vegetation of Yunan, Szechuen, Hupeh, and Formosa His collections are prized very highly at Kew. What he said regarding a collection of woods which he had sent home the first year is a very small matter. Dr. Henry's words in no way justify the expression, "heedless and unintelligent criticism of Kew."

My friends and those who are acquainted with the work which I have been privileged to do at Kew thirty years ago, and again during the last few years, know that I am quite incapable of sneering at scientific botanists, or of endorsing heedless and unintelligent criticism of the Kew Botanical establishment, which is unrivalled in the whole civilised world. But Sir George Birdwood's remarks may be read by others, who do not know me, and who may not have an opportunity of reading Mr. Stone's paper and the discussion which followed it. Hence I must ask permission to state these facts in your *Journal*. My only regret is that I did not see Sir George Birdwood's remarks earlier.

DIETRICH BRANDIS.

Kew, January 22nd, 1902.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 5.—"Jamaica." By HERBERT T. THOMAS. WILLIAM FREDERIC LAWRENCE, M.P., will preside.

FEBRUARY 12.—"Industrial Redistribution." By WILLIAM LEONARD MADGEN. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 6.—"The Coal Resources of India." By PROFESSOR WYNDHAM R. DUNSTAN, F.R.S. The Right Hon. LORD GEORGE HAMILTON, M.P., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 18.—"The French Canadian Relationship to the Crown." By W. T. R. PRESTON, Chief Inspector Canadian Government Emigration Agencies.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

FEBRUARY 4. 4.30 p.m.—"The History of the Rosary in all Countries." By the REV. HERBERT THURSTON, S.J. His Eminence CARDINAL VAUGHAN will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

SAMUEL RIDEAL, D.Sc., F.I.C., "The Purification and Sterilisation of Water." Four Lectures.

LECTURE IV.—FEBRUARY 3.—*Chemical Purification.*—Ozone—Hydrogen peroxide—Chlorine—Chlorine peroxide and hypochlorites—Bromine—Manganates and permanganates—Acids—Sodium bisulphate—Conclusion.

CYRIL DAVENPORT, F.S.A., "Personal Jewellery from Prehistoric Times."

LECTURE I.—FEBRUARY 10.—Primitive NECKLACES of shells and trophies—Torques—Assyrian and Egyptian necklaces, Greek, Roman and Etruscan—The "Diamond Necklace"—BRACELETS among savage nations and in India—Early Egyptian bracelets found at Abydos, and those found at Mycenæ, Troy, and the Crimea—DIADEMS from Troy and Mycenæ—Fillets worn by Roman Emperors, and Etruscan wreaths of gold—Byzantine circlets and crowns and the British crowns.

LECTURE II.—FEBRUARY 17—EAR RINGS, nose-rings, toe-rings, lip-rings, and finger-rings—Ecclesiastical, royal, and military rings—Posy and gimmal rings and ring anecdotes—Mediæval talismanic rings, mourning, puzzle, and watch rings.

LECTURE III.—FEBRUARY 24—BROOCHES and their development from pins—The Celtic pen-annular brooches, Merovingian circular and rectangular brooches and their derivatives—Buckles—Roman and Greek fibulæ—Scandinavian and Anglo-Saxon brooches, with cut garnets and niello work, and the heavy boars head brooches from Gotland.—PENDANTS as separate ornaments—The symbolical ornamentation of jewellery, swastika and triskele—Precious stones—Processes—Modern work—Summary.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "The Purification and Sterilisation of Water." (Lecture IV.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Barfoot-Saunt, "The Report of the Royal Commission on Local Taxation."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Inaugural Address by the President, Mr. Percy Griffith.

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Dr. A. Dupré, "The Explosion of Potassium Chlorate by Heat." 2. Dr. F. Clowes, "The New Table Photometer and Standard Pentane Burner prescribed by the Gas Referees for use in the London Gas-testing Stations."

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. C. F. Harford-Battersby, "The Native Races of Nigeria."

British Architects, 9, Conduit-street, W., 8 p.m. President's Address to Students.

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Professor Lionel Beale, "Water Essential to all Life."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. H. Reilly, "City Buildings—Old and New."

Tuesday, Feb. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Applied Art Section.) Rev. Herbert Thurston, S.J., "The History of the Rosary in all Countries."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. Macfadyen, "The Cell: its Means of Offence and Defence." (Lecture IV.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by—1. Mr. Joseph Davis, "The Sewage Systems of Sydney, N.S.W., and its Suburbs." 2. Mr. William Naylor, "The Bacterial Treatment of Trades Waste."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Edward Degen, "Ecdysis, as Morphological Evidence of the Original Tetradactyle Feathering of the Bird's Fore-limb." 2. Mr. G. T. Bethune-Baker, "A Revision of the *Amblypodia*-Group of the *Lycænidæ*." 3. Professor W. Blaxland Benham, "Notes on the Osteology of *Cogia breviceps*."

Wednesday, Feb. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Herbert T. Thomas, "Jamaica."

Geological, Burlington-house, W., 8 p.m. 1. Rev. Edwin Hill, "The Matrix of the Suffolk Chalky Boulder-Clay." 2. Professor T. G. Bonney, "The Relation of Certain Breccias to the Physical Geography of their Age." 3. Mr. E. A. Walford, "Some Gaps in the Lias."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m. Annual Meeting.

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

Thursday, Feb. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Professor Wyndham R. Dunstan, "The Coal Resources of India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. Darwin, "A Method of investigating the Gravitational Sensitiveness of the Root-tip." 2. Dr. D. H. Scott, "An Extinct Family of Ferns."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. G. F. Emery, "Company Promoters in Theory and Practice."

Society for the Encouragement of Fine Arts, 9 Conduit-street, W., 8 p.m. Mr. Alfred Gilbert, "An Evening with Mendelssohn" (with Musica Illustrations).

Chemical, Burlington-house, W., 8 p.m. 1. Prof. W. H. Hartley, "An Investigation into the Composition of Brittle Platinum." 2. Mr. M. O. Forster, "Conversion of *l*-hydroxycamphene into β-halogen derivatives of Camphor." 3. Messrs. S. Ruhemann and H. E. Stapleton, "Tatrazoline." (Part II.) 4. Mr. J. S. Lumsden, "The Solubilities of the Calcium Salts of the Acids of the Acetic Acid Series." 5. Mr. J. S. Lumsden, "The equilibrium between a solid and its saturated solution at various temperatures." 6. Mr. W. R. Innes, "The influence of temperature on association in benzene solution, and the value of the molecular rise of boiling point for benzene at different temperatures." 7. Dr. W. H. Perkin, "The Magnetic Rotation of Ring Compounds; Camphor, Limonene, Carvene, Pinene, and some of their derivatives." 8. Mr. O. Silberrad, "Polymerisation Products from Diazoacetic Ester."

Royal Institution, Albemarle-street, W., 3 p.m. Rev. John Watson, "The Scot of the 18th Century." (Lecture I.) At Home.

United Service Institution, Whitehall, S.W. 3 p.m. Lieut.-Col. F. N. Maude, "Continental versus South African Tactics: A Comparison and Reply to some Critics."

Civil and Mechanical Engineers, St. Ermin's Hotel, Caxton-street, Westminster, S.W., 8 p.m. Mr. F. H. Hummel, "The Statics of Bridges."

Friday, Fbe. 8...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor E. Ray Lankester, "The New Mammal from Central Africa, and the Giraffe-like Animals."

North East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. Mr. D. B Morison, "Report on Memorandum submitted to the First Lord of the Admiralty on the 16th day of July, 1901, with reference to the present unsatisfactory condition of the Engineer Branch of H.M. Navy."

Geologists' Association, University College, W.C. Annual Meeting. President's Address on "A Dozen Years of London Geology." (Eocene, Chalk, and Underground.)

Junior Engineers, Westminster Palace Hotel, S.W., 8 p.m. Mr. William J. Cooper, "The Electric Passenger Elevator."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Feb. 8...Aeronautical Institute (at the House of the Society of Arts), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr W. H. Hadow, "Landmarks in the History of Opera." (Lecture IV.) Wagner.

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FRIDAY, FEBRUARY 7, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, February 10, 8 p.m. (Cantor Lecture.) Cyril Davenport, F.S.A., "The History of Personal Jewellery from Prehistoric Times." (Lecture I.)

Wednesday, February 12, 8 p.m. (Ordinary Meeting.) William Leonard Madgen, "Industrial Redistribution, and its connection with the Overcrowding Question."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

Dr. Rideal, F.I.C., delivered on Monday evening, 3rd inst., the fourth and last lecture of his course on "The Purification and Sterilisation of Water."

On the motion of the Chairman, a vote of thanks was passed to the lecturer.

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday, February 4, 1902; His Eminence Cardinal Vaughan in the chair.

The paper read was "The History of the Rosary in all Countries," by the Rev. Herbert Thurston, S.J.

The paper will be published in a future number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

INDIAN SECTION.

Thursday, February 6, 1902; The Right Hon. Lord George Hamilton, M.P., in the chair.

The paper read was "The Coal Resources of India," by Professor Wyndham R. Dunstan, F.R.S.

The paper and report of the discussion will be published in a future number of the *Journal*.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

The Council of the Society of Arts have determined to add to the existing system of examinations, *vivâ voce* examinations in modern languages. At present it is proposed to hold such examinations in French, German, and Spanish; other languages will be added as soon as a demand arises. It is the hope of the Council, that eventually it may be possible to require all candidates in modern languages to pass a *viva voce* examination, as well as a written one, and to restrict the issue of certificates to such candidates.

The examinations will be held at any date, at any of the Society's examination centres, where the local Committee will undertake to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate, for not less than 24 candidates. Unless as many as 50 candidates are entered, the local Committee will also be required to pay the examiner's travelling expenses, including first-class railway fare from London, to the place where the examination is held. The Committee will also be required to defray all the local expenses, and to provide a convenient room for the examination, together with a suitable waiting-room for the candidates. To cover such expenses an additional fee may be charged. Such arrangements may be made as may be convenient for the simultaneous examination of all or part of the candidates in Dictation. Except as regards the Dictation part of the examination, no person, except the examiner and the candidate under examination, should be allowed in the examination room while the examination is going on.

The examination will include Dictation, Reading, and Conversation. Candidates will be expected to satisfy the examiner in all these branches. Candidates who do so will receive a certificate of proficiency in Colloquial French, German, or Spanish, if, in the opinion of the examiner, they can express themselves fluently in the language selected; minor grammatical errors will not prevent success. The candidate's grammatical knowledge will be tested, as hitherto, by the written examinations of the Society in modern languages.

The examination might be held for 2½ hours in the morning, 2 hours in the afternoon, and 2 hours in the evening. It is calculated that an examiner will be able to examine eight candidates per hour, or about 50 per diem. But the time and duration of the examination can be arranged to suit the convenience of the local Committee, on the understanding that it does not last for more than 6½ hours in all, with suitable intervals.

In order to secure uniformity of standard, it is intended, at all events for the present, that all the examinations in each language shall be conducted by the same examiner.

The Committees of different local centres may, of course, combine together for the purpose of holding a joint examination in their locality.

Secretaries of local Committees desiring to hold *vivâ voce* examinations should communicate with the Secretary of the Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

NINTH ORDINARY MEETING.

Wednesday, February 5th, 1902; WILLIAM FREDERIC LAWRENCE, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Barringer, Herbert, M.I.N.A., 78 Gracechurch-street, E.C.
Garnett, Tom, Radeclyffe, Clitheroe.
Hall, Prof. Charles James Sculthorpe, F.R.I.B.A., Apartado 99, Puebla, Mexico.
Herdman, George Walker, M.A., B.Sc., A.M. Inst.C.E., 2 Fyfield-road, Enfield, Middlesex.
Khanji, Prince Yaver Hussain, The Palace, Palanpur (R.M. Railway), India.
Lubeck, Luiz Adolpho, 2 Canton-road, Shanghai, China.
Wood, Ernest Seymour, F.G.S., 5 Fairlie-place, Calcutta, India.
Wurster, Dr. Casimir, Dudley-mansions, 29 Abbey-road, St. John's-wood. N.W., and Kaiser Friedrich-Platz 2v, Berlin, Germany.

The following members were balloted for, and duly elected members of the Society:—

Braun, Henry Charles, 236, Pentonville-road, King's-cross, N.
Charles, Miss Bessie Ada, A.R.I.B.A., York-street-chambers, Bryanston-square, W.
Clarke, Caspar Stanley, 92, Cromwell-road, South Kensington, S.W.
Elstob, Charles, 6, Bradford-avenue, E.C.
Harris, William R. Alexander, Soho Mills, Wooburn, Wooburn-green, S.O., Bucks.
Reilly, Edward P., Cape Town and District Gas-light and Coke Company, Long-street, Cape Town, South Africa.
Tetley, Robert B., Lightwater Grange, Bagshot, Camberley.

The CHAIRMAN, in introducing the reader of the paper, said he feared that many people thought Jamaica was like some of their poor relations—the less they saw and heard of the island the better. He thought, however, that Jamaica and the West Indies ought not to be considered in that light. One hundred and fifty years ago they largely figured in the history of England, being the cause and subject of some of the greatest naval contests that this country had had with other European powers. In those days they were looked upon as one of the Eldorados of the world, and were highly prized; now they had fallen upon evil times, for reasons which probably Mr. Thomas would explain. Mr. Thomas had served in H.M. Constabulary in the island for about 25 years, and was very conversant with everything that had been going on there of recent times. Born and bred in the island, and having come home for his education, he had gone back again to the island with which he was so closely connected, and was prepared to give an up-to-date account of its present condition.

The paper read was—

JAMAICA.

BY HERBERT T. THOMAS.

The Island of Jamaica is situated in the Caribbean Sea, between 17 and 18 degrees north of the Equator, and is the third in size of the West India Islands. It lies at a distance of about 4,050 miles from England, and is 144 miles in length, its width varying from 50 to 22 miles; while its total area is 4,200 square miles. It lies about 500 miles due east of the point at which the Panama Canal, or any other waterway that may be constructed across the isthmus, must open into the Atlantic; and this fact renders its position of the greatest importance as a naval base: the more so as it possesses a magnificent harbour some ten miles in length, completely protected —in fact almost land-locked—by a long sandy spit of land called the Palisados. At the western extremity of this is situated the small town of Port Royal, with an important naval dockyard and hospital.

The approach to the harbour is dangerous and intricate, owing to the numerous coral islets which are scattered about it; and it is, in addition, commanded by three or four forts of recent construction, which are capable of converging a perfectly irresistible fire upon any hostile fleet which might attempt an entrance.

The name "Jamaica" is said to be derived from that bestowed on the island by its aboriginal inhabitants, a tribe of Arawâk Indians, to whom it was known as "Chamakia" or "Xaymaca," a compound word signifying "abounding in woods and streams," a name which aptly describes the most prominent physical features of the island. Roughly speaking, it consists of an enormous backbone of mountain running throughout its whole length from east to west, and throwing out a bewildering tangle of spurs and cross-ridges, which for the most part descend more or less precipitously into the sea, and only here and there open out into plains, the largest of which does not extend more than twelve miles inland at its widest point. Of interior plateaux or high table-lands there are practically none. In fact there is a legend to the effect that Columbus, when asked by Queen Isabella of Spain to describe to her what Jamaica was like, crumpled up a sheet of paper in his hand, and, setting it on a table, pointed to it as affording the best illustration he could give of the physical configuration of the country. He could not possibly have hit upon a more apt one. This will be evident from the fact that of its 4,200 square miles of area, only about 2,200—or little more than half—lie at less than 1,000 feet above sea-level; while in the Blue Mountain range, at the eastern end of the island, the highest peak attains an altitude of 7,450 feet. This entire mountain range is clothed with vegetation up to the very summit. There are no bleak and barren peaks standing aloft; all are clad with a mantle of dense virgin forest of so dark a verdure as to lend the tint of deep azure, which earns the name of "Blue Mountains." In nearly every ravine of this mass of mountain, especially in the east and on the northern slope, water abounds. Streams leap and dash over the black rocks under the shade of the forest trees, or, in the limestone region, burrow their course underground, emerging now and then for a brief space into the light of day, and unite to form large rivers which flow into the sea on the north and south sides of the island. Owing to the precipitous formation of their beds, only two of these rivers are navigable for any distance from their mouths.

The island is divided into 14 parishes; and these divisions correspond in some measure to those of counties in England. Each has its chief town, lying, with two exceptions, on the sea coast, and containing the headquarters of the various public offices: courts of law, customs, inland revenue, police, &c.

The chief of these towns is Kingston, the capital of the island, which is situated on the north shore of the harbour described above. A line of railway runs from Kingston westward to Spanish Town, the former capital, and thence on to Montego Bay on the north coast, 120 miles distant; while a branch line goes to Ewarton, a small town in the interior; and another turns eastward again and terminates at Port Antonio, the headquarters of the fruit trade: a town which may be said to owe its existence entirely to American enterprise.

Besides these railways the island is traversed in every direction by excellent driving roads, one or two of which attain a height of 3,000 to 4,000 feet above sea level; and the admirable manner in which they are kept, in spite of the torrential rains to which they are subject, and the steepness of the gradients which are often necessary, is a never ceasing source of wonder to the numerous American tourists who visit the island every winter.

Besides the General Post Office in Kingston there are 120 district post-offices throughout the island, and of these sixty-eight are also telegraph offices from which it is possible to send a message to any part of the civilised world; the island being served by two ocean cables, namely, the West India and Panama, and the Direct West Indian lines.

Jamaica was discovered by Columbus on his second voyage to the New World, on the 3rd May, 1494. He found it inhabited by an unwarlike and gentle tribe of Arawâk Indians, living mostly on the seashore and subsisting principally on fish, in the catching of which they had become very expert. The island remained in the possession of the Spaniads until 1655, when it was taken from them by an English expedition despatched by Cromwell's orders. The history of the island during the Spanish occupation is practically a blank. All that we know for certain is that the Spaniards, according to their traditional custom, exterminated the gentle Arawâks by slow degrees; and one of their own historians has left some record of the cruelties by means of which they accomplished this. Also that they imported negro slaves from West Africa for the purposes of agricultural labour, and that many of these made their escape to the trackless forests that covered the mountains of the interior, and joined the small remnant of Arawâks who had also taken refuge from their oppressors, thus forming the nucleus of the people known as Maroons, whose history is of sufficient interest and importance to form the subject of a separate treatise.

The importance of Jamaica as a naval base for the Gulf of Mexico and the Spanish Main was very quickly recognised, and the town of Port Royal in the early days of the British occupation was the favourite haunt and fitting-ground of numbers of men who were little better than pirates. The most noted among these was Henry Morgan, the conqueror of the town of Panama. He was afterwards knighted, and appointed Lieutenant-Governor of the island of Jamaica.

But more honoured names than his are known in Jamaica: those of Benbow, Rodney, and the great Nelson himself. The first lies buried in the chancel of the Kingston parish church, having died of the wounds he received in a victorious action with the French fleet under Admiral Du Casse in 1702; the memory of the second is perpetuated by a handsome statue, flanked by two of the guns which he captured from the French Admiral de Grasse at the celebrated action in 1782, which saved the island of Jamaica, and, probably, all the British possessions in the West Indies from capture; while a tablet let into the wall of one of the forts at Port Royal records the fact that the pavement was once trodden by the feet of the immortal Nelson. The most notable event in the history of Jamaica of late years was the deplorable outbreak at Morant Bay in 1865, when Governor Eyre suppressed what was undoubtedly an incipient rebellion, under circumstances which caused considerable excitement and acrimonious discussion in England at the time.

The island is now ruled by a Governor and a Legislative Council, consisting partly of elected members—one from each parish—and partly of certain officials and nominees of the Governor.

The population of Jamaica should be now very close upon 800,000. The Government could not this year afford the expense which the taking of a census would entail, but taking the figures yielded by the last and previous ones, and allowing for the same ratio of increase which they give, the number to-day may be safely put at 800,000. Of this number only about 14,000 are whites, and these include the European garrison and the Navy; so that the number of permanently resident whites is in a very small proportion indeed. And this white population is shown to remain practically stationary from decade to decade, while the coloured and black population increases at the rate of 42 per 1,000; thus the white element is in danger of being swamped entirely.

A small proportion of the population consists of East Indian coolies, who have been brought over from time to time as indentured labourers on the sugar plantations; and there are also a few hundred Chinese; so that the population of the island presents every conceivable shade of colour,—white, yellow of various shades, brown, chocolate and copper-colour, and black.

But the whole of this motley and heterogeneous population is intensely loyal to the British flag and devoted to the Crown. On the occasion of Queen Victoria's death, there was scarcely a woman in the island, however poor, ignorant and humble, who did not display some token of mourning; and during the stress of the South African War the local militia were not a whit behind the rest of the Empire in offering their services to the mother country, but their offer was declined on the ground that it was to be entirely a "white man's war."

Elementary education in Jamaica is free, but not compulsory; and the latest returns available show a total of 98,598 pupils enrolled on the books of the schools, with an average attendance of 61,219. The cost to the Government in 1899-1900 amounted to £47,330, or very nearly one-tenth of the total sum expended by the Government on the administration of the entire public service of the island. The children in attendance at these elementary schools may be described as being all coloured and black.

There are also several higher schools, endowed by various trusts, and assisted by the Government; and the standard of education imparted in these is second to none in the Empire. At the Cambridge Local Examinations, which have a centre also in Jamaica, three times within my own recollection has a Jamaica boy passed first in the whole area of the Empire which is embraced by these examinations. This happened only last year, the successful candidate being a black boy; and the high proportion of "passes" obtained by the Jamaica High School at that examination — amounting to 100 per cent. of the candidates entered—elicited from the examiners a special complimentary report. The masters of these higher schools are for the most part English University men; while those of the elementary ones are natives, trained locally in an institution which exists for that purpose in Kingston. This institution is the outcome of a bequest made in the year 1670 by Dame Jane Mico, the widow of Sir Samuel Mico, Knight, of the City of London, of the sum of £2,000 for the purpose of redeeming Christians who had been captured by Algerian pirates. The object to which the money was to be devoted having ceased to exist, it accumulated, until in the year 1834 it amounted to no less than £120,000, when, through the exertions of the late Sir Thomas Fowell Buxton, it was diverted by order [of the Court of Chancery to the endowment of institutions for the education of the black and coloured children of the West Indies.

The products of Jamaica are as numerous and varied as are its climate and degrees of temperature at various altitudes. Its soil is, in most districts, of wonderful fertility; and of it one may truly say that it has only to be tickled with a hoe to make it laugh with a harvest. A great number of those products now rot uselessly on the ground, and still await the touch of capital and enterprise to convert them into sources of wealth. *Oranges*, golden and luscious, grow wild. Only within the last six or seven years, since their value as an article of export has begun to be more and more realised, has any attempt been made at systematic cultivation, and improvement by budding and other processes. The sour *Seville oranges*, of whose rind the most delicious marmalade is made, literally wither on the trees or rot on the ground by millions year by year. The same is true in an even higher degree of the *guava*, the fruit from which the well-known luscious jelly is prepared. In some districts the tree is positively a noxious weed, and has to be cut down and cleared away by the acre to make room for cultivation of other products.

As a matter of fact, in spite of these circumstances, orange marmalade, manufactured in England or Scotland, and imported into Jamaica, can be purchased at a less price than the manufacture of the home-made article costs; and the same would no doubt be the case with guava jelly, if the latter fruit could be procured at home, as oranges are, from other sources. The cause of this apparent anomaly lies in free trade, which has the effect of making the sugar necessary for these manufactures a more expensive article in Jamaica, where the sugar itself is made, than it is at home. And this brings us by a natural process to the discussion of *sugar* itself, and its concomitant, *rum*, which were once the staple of the island, but have now fallen on such evil times, owing entirely to the operations of the free trade principle, as to constitute jointly only 18 per cent. of the total value of the exports. The decay of this industry cannot, I think be more forcibly illustrated than by the statement that, whereas at the beginning of the 19th century there were upwards of 800 sugar estates in cultivation, there are to-day no more than 121. The famous rum of Jamaica, which is a household word, has been so largely superseded, even in the island itself, by whiskey, that it is now little more than a recollection and a name. There is, however, a particular description of rum which is only manufactured on certain estates in one district of the island, and which, although utterly unfit for human consumption in its natural condition, is much prized in the German market, and is eagerly bought up at prices which appear enormous when compared with those given for the ordinary kinds.

The place once occupied by sugar in the trade of Jamaica has now been completely usurped by fruit: first the *banana*, and then, a long way after, the *orange* and the *pineapple*. In the year 1875 the first load of bananas was taken away from Jamaica to the United States in a small schooner by a Yankee skipper. In 1879 the total value of the fruit exported from Jamaica was estimated at £40,000, while in the returns for 1899-1900 it is set down at £814,000. These bare figures describe the growth of the fruit trade more eloquently than any words possibly can do. And this trade is entirely the offspring of American enterprise. The Yankee skipper above-mentioned is now the head of the Jamaica branch of the gigantic concern known as the United Fruit Company, whose headquarters are at Boston, Mass., with offices in New York, Philadelphia, Baltimore, and numerous other places in the States, in Central America, and in the West Indies; notably, since the termination of the Spanish-American War, in Cuba and Porto Rico. They own hundreds of thousands of acres of land in

Jamaica, employ thousands of labourers, and use thousands of head of horses, mules, and cattle. They contribute thousands of pounds to the Inland Revenue and the Customs of Jamaica, over and above what they spend in wages, &c. Besides shipping their own fruit, they purchase millions of bunches from other growers, and, in the busy season, which lasts from April to July, they despatch from twelve to fourteen steamers a week laden with fruit. They have laid down tramways, and strung telephone wires round half the island. They have converted the town of Port Antonio from a fishing village into a thriving, bustling, business centre. They have built a fine hotel there, on one of the loveliest spots in the whole island, and they fill it every winter with hundreds of tourists brought down from the States in their own steamers, whose money circulates in the island to the common benefit. They have prevented the eastern and north-eastern districts of the island, where the sugar industry fell into decay more rapidly than in any other part of it, from relapsing into the condition of a primeval African wilderness. In short, if there is one man in the world to whom the grateful inhabitants of Jamaica should erect an imperishable monument, that man is the Yankee skipper who took away that load of bananas in 1875.

The Americans are more a nation of fruit-eaters than the English; and it is to this fact, and to their recognition of the actual food value of the banana, that the continued increase of the demand for it is due. It is becoming a common article of diet among the working classes; and we hope to see the day before long when its value in this respect will be equally recognised in the mother country.

In this direction a determined and laudable effort was begun last year by a man who has been aptly described as a "Napoleon of commerce." He is now Sir Alfred Lewis Jones, K.C.M.G., the head of the firm of Elder Dempster and Co. He has built a small fleet of four steamers which ply direct between the port of Bristol and Kingston, Jamaica, making the voyage in twelve to thirteen days. By the terms of his contract, he is bound for a period of five years, to purchase in the island a minimum of 20,000 bunches of bananas every fortnight, for sale in the United Kingdom. I well remember the interest and anxiety with which the arrival of the *Port Morant*, the pioneer vessel of the fleet, was awaited throughout the island in February last, and the crowds which thronged the wharves to watch her progress up the harbour when her approach was signalled. It was felt that the links which bound the ancient British colony to the mother country, neglected and almost rusted through, were now being forged afresh, and that a new era was about to dawn. And I remember how eagerly the telegram was longed for which should announce the arrival of the ship at Bristol, and the condition of her cargo; and what a wave of relief and rejoicing swept through the island when news of the best was flashed across the wires. Since then the venture has made steady progress, and the fruit trade between Jamaica and England may be regarded as being established on a firm basis. Experience and resolution have corrected the faults and overcome the drawbacks inseparable from the initial stages of such an experiment, and the tide is steadily flowing, never again, let us hope, to ebb.

Not content with exploiting the fruit trade, Sir Alfred Jones has insisted on the advantages of Jamaica as a health and a winter resort—with which I shall deal later on—and has leased from the Government the two principal hotels of the island, placing them under such management that the tourists and invalids whom he conveys thither in his steamers may enjoy to as great a degree as possible the comforts to which they are accustomed at home.

The first-class return fare is only £32, and the voyage—in itself a pleasure and a substantial benefit to those in weak health – lasts but from twelve to thirteen days each way.

The principal disadvantage attending the cultivation of the banana is the danger of destruction by gales of wind that would not affect any other description of cultivation. Added to this is the careful handling which the fruit requires to prevent its being rejected by the buyers on account of bruises. On the other hand the profits are enormous and may be calculated at not less than from £9 to £10 per acre per annum. Thus damages by storm or flood can always be amply recouped within twelve months, the period which elapses between the planting of the sucker and the reaping of the mature fruit.

An excellent, nutritious, and easily digestible flour is made from the green fruit; and the development of this branch of the industry only awaits the discovery of some process by which it will be possible to produce the flour so cheaply as to enable it to compete with wheaten flour. When that shall have become an accomplished fact, millions of bunches which are now unmarketable and are thrown away, or given as food for pigs and other stock, will be turned to use and profit.

Pineapples are now receiving great attention in Jamaica. Certain kinds of them bear transport better than any other description of fruit with which I am acquainted. Some fellow-passengers of mine brought over several in May last, simply stowed underneath the berths in the cabin, and on our arrival at Bristol, they looked as if they had been gathered the previous day.

The Jamaica orange is second to none in flavour and juiciness, especially the kind which grows—practically quite wild—in the parish of Manchester. Readers of Mr. Froude's "Bow of Ulysses," will remember his almost rapturous description of the Mandeville orange. The great bulk of this fruit is now shipped to the United States; and as already stated, it is being systematically cultivated. Experts who have been driven out of the state of Florida—Jamaica's chief rival in the American orange market—by repeated frosts, have migrated to Jamaica and turned their attention to the cultivation and packing of the fruit there. This product is also receiving its due share of attention at the hands of Sir Alfred Jones; and I have been greatly gratified by seeing in the fruiterers' shops in Bedford, Jamaica oranges which in appearance and flavour leave nothing whatever to be desired.

The cultivation of *cocoa* has very largely increased of late years. It is now planted, almost as a matter of course, in all the banana fields, where the bananas afford the young plants the shade which is indispensable to them for the first year of their existence. The same soil suits both, and the one cultivation does not interfere with the other in the slightest degree. At the same time the art of curing the cocoa is much better understood than was previously the case, and the Jamaica product is now steadily bridging the great gulf in price that not long since lay between it and the celebrated Trinidad cocoa.

Coffee has shared the fate of most other products, and suffered disastrously in competition with other producing centres of vast extent which are being opened up year by year; but the delicate Blue Mountain coffee, which is grown at high altitudes among the mountains, still maintains its reputation for unrivalled flavour, and has not been affected by competition in the same manner as the lower grades.

I am unable to assign any reason for the fact that the excellence of the Jamaica *tobacco* is not more widely known in the United Kingdom. It is a fact that as good a cigar, of local manufacture, can be purchased in Jamaica for twopence, as would cost at least sixpence in London. The manufacturers of the island supply it entirely with cigars, and to a great extent, with cigarettes, manufactured almost exclusively from native-grown tobacco, only the outer leaf or "wrapper" being imported; but it does not appear that any attempt has been made to establish export trade on a large scale. The tobacco trade has hitherto been exclusively in the hands of Cubans, who, driven from their own country by constant rebellions and Spanish oppression, have settled in Jamaica, in considerable numbers, most of them becoming naturalised as British subjects. But this industry is now receiving the attention it deserves at the hands of a gentleman who brings to bear upon it not only wealth, but position and influence. He is the Hon. Evelyn Ellis, uncle of the present Lord Howard de Walden, and a large land owner in the western part of the island. He has there established a tobacco plantation which is already the largest, under the control of any one man, in the world. Factories have been erected on the spot, and cigars and cigarettes are being turned out in large quantities. There is also a chemical laboratory in which highly skilled experts experiment with numerous other products that now run to waste. There is not the least doubt that Mr. Ellis's exertions will be of incalculable benefit to the island, especially if he takes up the matter of an export trade in cigars to the mother country. He it was who entirely revolutionised the breeding of cattle for draft purposes in the island by importing stock from India to his magnificent properties in Jamaica, which, crossed with the native breed, make the most ideal draft oxen that can be desired. His herds now practically supply the whole island, and his annual sale is a great event among the sugar planters in the western districts.

Another industry which has only very recently sprung into existence, and in the future of which I have great faith, is the cultivation of *rice*. Rice is very largely in use as an article of food among the negroes, and there are thousands of acres of swampy land, utterly useless for any other purpose, which might be profitably turned into ricefields. I myself witnessed the first experiment which was made in the vicinity of the town of Falmouth, on the north side of the island, and can testify both to its success as a commercial venture, and the improvement to the town effected by it from a sanitary and an aesthetic point of view.

There are still a great many erroneous ideas prevalent in England about the climate of Jamaica, ideas for which such novels as "Tom Cringle's Log," "The Cruise of the Midge," and some of Captain Marryat's are largely responsible. They breathe an atmosphere of rum and yellow fever; a merry riotous life of debauchery terminating in sudden death by Yellow Jack. They may have been faithful pictures of Jamaica life at the end of the 18th and the early part of the 19th centuries, but they have long ceased to be such. In the first place, I beg to assert in the most positive manner that the dreaded yellow fever is *not* indigenous to Jamaica. Every outbreak which has occurred there has been due to a case imported from Cuba or South America, where it is endemic; and against all vessels arriving from those parts the most rigid quarantine regulations are strictly enforced. And when the experiments now being conducted to test the theory of the propagation of the disease by means of the mosquito shall have confirmed that theory—as all results hitherto obtained appear to indicate—its prevention will become a comparatively simple matter.

There are swampy and, consequently, unhealthy districts on the coast where malarial fever prevails, but it is evident that in a country, one-half of whose area lies from 1,000 feet above sea level upwards, any degree of coolness can be obtained by simply ascending to a higher level. The detachment of the English regiment quartered at Newcastle, 4,000 feet above the sea, and their wives and children are just as fresh and rosy of complexion as they are at home; and even when they move down to the plains for a course of musketry at Up Park Camp, with the care which is nowadays given to sanitation, their standard of health is in no way lowered.

In the year 1889 Brigade-Surgeon Maunsell (since deceased), then the senior officer of the Army Medical Department in Jamaica, compiled statistics from the year 1817, the first in which any records were available up to 1889. He found, as the result of his investigations, that whereas the death-rate amongst the troops from 1817 to 1836 was 121·3 per thousand, in the last decade of the period under review, namely, from 1880 to 1889, it had fallen to 11·36, or just about one-eleventh of what it had been in the first twenty years. Here again we find figures more eloquent than words. His calculation includes deaths from *all* causes, and has no particular reference to fevers or any other specific tropical diseases.

In certain parts of the island the climate has a marvellously beneficial effect upon persons suffering from pulmonary complaints. I could shew you half-a-dozen people to day with respect to whom I should not be in the least offended if you declined to believe my assertion, that they had gone to Jamaica as a last resort to avoid death by consumption.

Even in Kingston, lying as it does on the sea coast, a series of observations recorded over a period of ten years shews a temperature ranging from 70 to 87 degrees; that is an equable temperature of limited range, and not subject to those sudden changes which so pre-eminently distinguish the climate of England. In the mountains most of the houses are provided with fire-places, and in January or February a fire of fragrant cedar or pimento logs is by no means unacceptable; while on the Blue Mountain Peak I have myself seen the thermometer down to 40 degrees. Furthermore the heat in the lowlands is, certainly for eleven months of the year, tempered by a seabreeze during the day and a land wind at night.

There are two rainy seasons, in May and October; and the coolest and pleasantest time of the year is from November to April. Then, instead of fog and snow, and slush and frost, we have blue skies and balmy breezes. The average annual rainfall of the whole island for the past ten years has been 76 inches; but this varies considerably in different districts, that embracing the forest-clad range of the Blue Mountains getting as much as 112 inches in a year. I have myself seen as much as 19 inches fall in one single night in this district during the torrential rains of October.

The principal charm of Jamaica lies in its scenery. It has not that oppressive, almost repellent profusion of vegetation and gorgeousness of colouring which one associates with tropical scenery. It is a mixture of tropical scenery, chastened and refined, with its wantonness kept within bounds, and Scotch and Welsh landscape, warmed into luxuriance, and developed by tropical rain and sunshine.

On the coast by the mouths of the rivers lie sometimes fetid swamps, across the depths of whose brown stagnant water the roots of the mangrove straddle like giant spiders; but I could take you to districts where, but for the presence of the grateful plumes of the bamboos overshadowing the streams and ponds, and an occasional cocoanut palm, you might easily imagine yourself in an exceptionally fertile English grazing country. I could take you higher still, and shew you dogroses and blackberries growing by the wayside, red and yellow gladiolas blooming among the coffee trees, and hedges of scarlet geraniums three feet high encircling gardens containing nothing but English blossoms. We could go still higher and feast on wild strawberries until our teeth were on edge; or we might wander along the banks of rippling streams under the golden balls of the acacia blossom amid thickets of pale red amaryllis lily, and clusters of night-blooming cereus trailing from tree to tree. There are caves of opal-tinted water fringed with coral beaches, where the maidenhair fern clothes the rocks almost down to the water's edge, its delicate fronds often blighted by the salt spray. And there are rocky gorges where the mountain torrent flashes and roars along a hundred feet below the path, while the stately tree ferns nod overhead amid clusters of pink, and white begonia blossoms, and wreaths of crimson ipomoea.

Then at evening, with your day's wandering at an end, you may listen to the gurgling music of the bull-frogs and the chirp of the crickets, and watch the fire-flies flit in and out among the branches, while the land wind rustles the leaves of the tall cocoanut palms, and the silver moon floods the landscape and the rippling wavelets of the sea at your feet with a mellow light.

And you may wander from one end of the island to the other in perfect security from wild animals. There never were any *venomous* snakes, and since the introduction of the mongoose from India those that there were have been completely exterminated.

As some information regarding the social condition of Jamaica may not be without interest, I will conclude this paper with some remarks on the subject. We have not, as is the case in the United States of America, any race or colour "problem" to solve. The white people of the island constitute, roughly speaking, the "classes;" but on the same footing as these, and mingling with them on terms of perfect equality, are numbers of well-to-do coloured people, of various shades of complexion, well-educated, cultured, and travelled, many of them occupying high positions in the public service, and practising as lawyers and doctors, and holding office in the church. An official social function at Goverment House, for instance, is a very motley affair as far as complexions go, but all the guests are on terms of perfect equality.

The negroes, who constitute the bulk of the population, and are the labouring classes, are contented and happy. They are as proud of being British subjects as any of their white countrymen; and nature is bountiful to them in the way of supplying their simple wants. I do not propose to enter into any dissertation on their faults and vices, but it should be remembered that it is only a little more than 60 years since they began to enjoy to the full the blessings of civilisation; therefore it is unfair to judge them by European standards. It seems reasonable to infer that the virtues which distinguish northern races have been engendered and fostered by rigours of climate and the struggle for existence. Stimuli of this description are lacking in the regions where it is "always afternoon," and therefore the moral standard is necessarily a lower one. But this much I can say about the Jamaica negro: that he is extremely temperate in the matter of drink, and comparatively free from serious crime. Those horrifying cases of wife-beating that figure so constantly in English criminal records never disgrace ours. Our black fellow-subjects are good-natured, and not in the least vindictive; they want principally to be let alone. Occasional thinly-veiled attempts are now and then made by some of the better-educated among them—men who owe everything they know to the white man's kindness—to stir up race hatred and to persuade them that they are oppressed and downtrodden; but the negro, simple as he seems, has a good deal of sound common sense, and is a very shrewd judge of human nature, so that these attempts at agitation invariably meet with the fate they deserve.

The law is supreme in Jamaica, as it is in every land where our glorious flag flies; and it is very efficiently enforced by the police, the rank and file of which are all black and coloured men, and by whose loyalty I, as an officer of that force of twenty-five years' standing, am personally quite willing to stand or fall, should the occasion ever arise for putting it to a crucial test.

In short, the population of Jamaica, consisting though it does of so many heterogeneous elements, presents the aspect of a peaceable, well-ordered law-abiding community, which is regulated and administered in accordance with the best traditions of British rule, and which is distinctly a credit to the British Empire.

DISCUSSION.

The CHAIRMAN said, speaking from a personal knowledge of Jamacia, he considered the paper very trustworthy and interesting. He was particularly glad the reader had drawn attention to the fact that the island was so very peaceable and law-abiding. So much was now heard of the Southern States of America, where the racial feeling was very strong, that it was gratifying to those who went out to British colonies to find that the racial feeling was reduced to a minimum. It spoke volumes for the British rule in those islands, that such pleasant relations existed between blacks and whites in the dominions of His Majesty. An American scientific gentleman employed in Jamaica had told him that he could travel the length and breadth of the island night or day without any accident ever happening. He was very glad Mr. Thomas had given such a spontaneous testimony to the merits of British rule. That testimony was more fully developed in print in a very interesting book, written by an American, called "Cuba, Porto Rico, and the West Indies," in which the author bore witness to the very happy results of British rule in Jamaica, and suggested that England should exchange peace-loving and law-abiding Jamaica and the other West Indian Islands for the Phillipines. He could quite understand that the United States would be glad to possess so fine a colony as Jamaica in order to get out of a very troublesome question in the Pacific. Mr. Thomas had spoken almost entirely of the east end of Jamaica. Personally he had the pleasure of knowing the west end. The circumstances there were very different from the rosy condition of affairs in the east. It was a peculiarity of Jamaica that the climate varied very materially in one part compared with the other. The rainfall in the east produced something like 100 inches a year, whereas it was only from 40 to 60 inches in the west, and hence arose the great difference between the cultivation of which Mr. Thomas had spoken. Bananas grew much more freely where there was plenty of rain, and consequently when the sugar industry was depressed in the east they been able to recoup themselves by growing bananas. He was sorry to say that in the west they had not been able to do as well as Mr. Thomas and his friends in the east. Owing to the fact that bananas did not grow so easily in the west, the United Fruit Co., which had been such a blessing to the island at large, particularly to the east, had practically done no business there, because when they grew the bananas they could not sell them. Mr. Thomas had said that a profit of from £9 to £10 an acre could be made from growing bananas. At the present moment he was selling stems of bananas for between 7½d. and 1s., and he did not realise anything like £9 or £10 an acre. Although he appreciated the merits of fruit growing, and although no sensible man would endeavour to decry anything that was likely to add to the staple of the island, those who had studied the matter most closely felt that the loss of the sugar industry would be a very grievous blow to the welfare of Jamaica. It was not enough merely to say that sugar had perished, and bananas had taken its place. A vast amount of capital, intelligence, educated cultivation, and handling of machinery required for sugar, fell into disuse with banana cultivation. He was endeavouring to run sugar and bananas at the same time. At the present time he could not sell his bananas, but when he did turn out a ton of sugar he could sell it to anybody. It could be carried by any ship, it could go to any port, and, as in the case of bananas, did not require a special ship, which took the fruit to Philadelphia or other ports where there where special means of distribution. There was no doubt that the cultivation of fruit was infinitely more risky than the cultivation of a great staple like sugar; and, therefore, those who wished well for the island, while they felt that Captain Baker had conferred an extraordinary boon on the island and regretted that he was an American and not an Englishman, felt it would be a thousand pities if the sugar industry in the West Indies was allowed to perish. At the beginning of the century Jamaica turned out as much sugar as all the West Indies put together; and what it did then it could do now, providing it was fairly treated. Captain Baker had said that free trade had ruined the West Indies and Jamaica. In his opinion, it was not the free trade but the unfairness of the trade. The sugar growers in France had a handicap at present of £5 in turning out a commodity which was hardly worth £10, and the Germans had a handicap of 25s. in turning out a commodity of a similar value. If the West Indies were put on the same level as the sugar growers in Europe, with the advantages Providence had bestowed upon them, with its splendid climate, plenty of labour, and ample capital, they would not come, hat in hand, to ask any favour at the hands of the British Parliament. He felt very strongly that the West Indies had been overlooked and forgotten in the last fifty years in that respect. Jamaica, like the other West Indian Islands, had no mineral resources, and was entirely dependent upon the results of cultivation. Sugar, too, when it was grown, required considerable intelligence on the part of a large number of people in the use of machinery.

Sir EDWARD WALKER, K.C.M.G., said that as i was more than 14 years since he severed his connection with Jamaica, he could not speak with authority on its present condition. Like Mr. Thomas, he had been surprised that Jamaica fruit had not found a firmer and wider hold in England. He had brought pines from Jamaica and distributed them in Devonshire amongst people who were accustomed to hot-house pines, and the remarks they had made after the practical experience of eating them were very favourable to the fruit. One thing in favour of the Jamaica pineapple, was that one never committed the offence of eating sugar with it, and he thought that proved the superiority of the Jamaica pine. The enterprise of introducing the banana into this couutry had not reached the success which he thought it certainly deserved owing to its excellent character. In appearance it certainly did not compare favourably with its rival, which was exported in large quantities and in excellent condition from the Canary Islands. He thought the shippers had not yet hit off the precise condition of ripeness in which the fruit should be shipped. With a friend, he had purchased, in the City of London, a Canary Island banana and a Jamaica banana, and they were both of the opinion that the Jamaica banana had the best flavour. Unfortunately it did not possess the fine, almost golden bloom, of its Canary Island rival, and, therefore, housekeepers in purchasing the fruit for table were liable to overlook the Jamaica banana. He could also bear testimony to the worth of the Jamaica cigar, and had heard on very high authority that there was no reason why Jamaica should not grow as good tobacco and turn out as good cigars as Cuba. He was particularly pleased to hear the tribute Mr. Thomas had paid to the Jamaica negro, who was not such a bad fellow as he was very often made out to be. In support of that contention one simply had to ask, Who did all the hard work in the Panama Canal? It was done by the Jamaica negro. The contractor for one of the smaller railway extensions carried out in the island of Jamaica, Mr. Murray Campbell, had said that in a large experience with various classes of labour, he was perfectly satisfied with the Jamaica labourer at a 1s. a day. In the past, difficulties had arisen which had stood in the way of better relations between the employers and the employed; but that was not to be wondered at when a similar state of affairs had existed between the employers and employed in England. He felt extremely grateful to Mr. Thomas for his extremely interesting paper.

The EARL OF STAMFORD said he could not speak from a very intimate knowledge of Jamaica, as he was only in that beautiful island for a week, but he came away with very vivid recollections of the place, and would always remember it as one of the most attractive and charming spots which he had ever seen in the world. He was extremely glad to hear of the very great improvement which had taken place in every respect since he visited the island 20 years ago. He remembered being very much struck at a time when the recollection of the Jamacia revolution was very fresh indeed, to notice the extraordinarily pacific state of the negroes. It showed what a placable race they were, and how soon the passions which had been stirred for a time died out. The reader of the paper had referred to the fact that the West Indies were comparatively little known. He thought the fault rested a good deal with the English people. The islands had been rendered far more accessible than they were a few years ago, through the institution of new lines of steamers, in which every comfort was provided for the passengers, while in the West Indies themselves spacious and comfortable hotels had been built. As one who knew and loved the West Indies, he believed they had only to be better known to be more appreciated. After a temporary sojourn in one of the islands, the traveller would come back greatly impressed by the way in which the English people had solved many of the important and pressing problems dealing with the native races, and would feel they had done good by their mere presence in the islands in testifying to the oneness of the Empire. Certainly they would come back in improved health and with an increased experience.

Colonel DAWKINS said that unfortunately he had found sugar growing a most ruinous business; and believed that until sugar growers were treated on equal terms throughout Europe it would be extremely difficult to grow sugar profitably in the West Indies. Exactly the same condition of affairs existed in Demarara. He did not think that banana growers had made much out of their cultivation, although undoubtedly the banana had proved itself to be a profitable investment to the Boston Company, which exported the fruit to America. While he hoped banana cultivation would be carried to its utmost limit as an accessory to the prosperity of the island, he felt with all West Indians and Jamaicans that sugar was the one thing without which they would never again see much prosperity.

Mr. CZARNIKOW thought that, unless the sugar bounties were abolished, the West Indies were doomed. Whatever benefits the banana and other fruits might bring to Jamaica, the staple industry was sugar, and without sugar the West Indies could not live.

Dr. T. E. S. SCHOLES said that he did not quite agree with Mr. Thomas's description of the contentment and complete satisfaction of the natives. In an article in that day's *Times*, it was announced that a deficit of £4,530 was anticipated next year in the revenue of Jamaica, and the article concluded with the significant words, "There is widespread poverty, and the business outlook still remains gloomy." The class of the population upon whom the pressure of that poverty rested most heavily, was the peasantry, so that a false impression was likely to be produced when the natives were described as thoroughly contented. He was afraid that there was an increasing tendency on the part of people in this country, and of the white races generally, to regard the coloured races as simply recipients. As a coloured man himself he felt that he was not in that position. While he received from the British, the British also received from him. They were working hand in hand. The coloured people certainly bore the burden of taxation, and, because they did so, they had a right to demand certain things, and if those things were not forthcoming, they were entitled to make a protest without being regarded as seditious. He thought it was important that the ruling race should bear that point in view, as it was often forgotten. Undoubtedly he would be told that the cultivation of sugar conferred a great benefit upon the West Indians by the circulation of money occasioned thereby. That was correct, but it did not cover the whole ground, because sugar enjoyed no immunity from taxation, and, as the peasantry bore the taxation, they assisted in bearing the burden of the sugar planting industry. As a loyal British subject he contended that it was only when the interests of all classes of the Empire were taken into consideration, and when every man, judged only by his ability and character, was given every chance, that the stability of the British Empire would be thoroughly assured.

Mr. THOMAS, in reply to Dr. Scholes, repeated the statement he had made in the paper, that occasionally attempts were made to stir up ill-feeling, but that those attempts always met with the fate they deserved, because their black fellow subjects had too much good sense. He was entirely in agreement with the Chairman's and other speakers remarks with regard to the sugar question. He was firmly persuaded that a perishable article like the banana could never be a staple of Jamaica; but the object of his paper was not so much to raise a discussion, as simply to state facts.

The CHAIRMAN, speaking not only on behalf of the planters, but for everybody dependent upon them—and every planter had certainly 100 and probably 200 black people dependent upon him—assured Dr. Scholes that it pained him very much to think of the low wages paid to the labourers, which was entirely owing to the low value of their produce. In his experience a planter had to lay out £10 on every acre of cane before he obtained a shilling for himself, and he was certain that last year very few planters succeeded in making a pound or even a shilling for themselves. When the planters were able to sell their sugar at a fair rate, and had a fair field and no favour, they would give the black labourers of Jamaica the wages they most decidedly deserved.

On the motion of the CHAIRMAN, a hearty vote of thanks was passed to Mr. Thomas for his paper.

Miscellaneous.

AUSTRALIAN LIGHTHOUSES.

No shores are more efficiently guarded by lighthouses and beacons than those of the Australian Commonwealth, especially those of New South Wales, where some of the finest lighthouses in existence are to be found. Although the Federal Government will ultimately take charge of the whole of the lighthouses in the Commonwealth, they at present remain in the hands of the respective States in which they are situated. Hence, the task of formally opening the latest constructed, that at Byron Bay, the eastern-most portion of New South Wales, was recently undertaken by Mr. John See, the State Premier, who, in the course of his speech, said that the length of the New South Wales coast-line from Green Cape on the south to Fingal Head on the north, was about 600 miles, and there were twenty-three lighthouses, including the one now opened, to light this extent of coast. The earliest of these was Macquarie Lighthouse at Sydney Heads, the foundation-stone of which was laid by Governor Macquarie in 1816. This was also the first lighthouse erected in the Southern Hemisphere, and was intended to be used for the several purposes of a signal and lighthouse, as well as a guardhouse and barracks for a small military detachment. This light was a revolving electric light, and was one of the most powerful lights in the world, being visible 25 miles at sea. The second light was the Beacon Light at Newcastle, erected in 1828; the third the floating lightship at the entrance of Port Jackson, in 1836. The original ones, of course, were insignificant structures, and had been long ago removed and replaced by more pretentious edifices: while in recent years the coast has been thickly studded with lighthouses, the equipment of which left little to be desired in the way of completeness and convenience. The total expenditure by the State in connection with lighthouses up to the end of 1900 was £253,790, of which £205,767 was expended on buildings and repairs, £27,152 on lanterns; and wages and miscellaneous expenses absorbed £20,871. Of the new lighthouse it is said that there is not a finer one, nor one more picturesquely situated, in the

State. The light, erected on a concrete tower, consists of a first order lantern, 12 feet in diameter and a first order revolving bivalve double flashing (pen Eclair) optical apparatus, manufactured by the Société des Etablissements Henri Lepante, Paris. The intensity of the flash is 145,000 standard English candles, and the apparatus rotates in a mercury bath at the rate of one complete revolution in ten seconds, there being altogether six flashes per minute. In addition to the main light there is a small fixed dioptric lamp in the tower on the floor, below the lantern room, to throw a subsidiary light over Juan and Julia rocks. The tower is 49 feet high from the ground to the floor of the lantern, and from ground to focal plane 61 feet. It is built of concrete blocks, rendered with cement inside and out, and is divided into three storeys by concrete floors, paved with black and white tiles. The foundations of the tower are down in concrete to a depth of 8 feet below the ground, the space therein being utilised as a rain-water tank of 3,000 gallons' capacity. Outside of the lantern there is an open gallery 4 feet wide, with a trachyte floor, paved with Val de Travers asphalte, and a trachyte parapet wall. A flagstaff is provided for signalling purposes and a flag-house has been built of concrete. The flagstaff is 60 feet high. The first work of preparing for the site, by levelling, &c., was commenced in October, 1899, and this part of the work was carried out by day labour, at a cost of £2,600. The main light is 371 feet above high-water, and it is visible at about a distance of 22 miles in clear weather. Cape Byron is 345 miles from Sydney, and about 30 miles from the northern boundary of the State.

MINERALS IN PERSIA.

On Persian soil there are many undeveloped treasures. There are numerous large petroleum fields in the country, not one of which is worked to any extent, much less in a systematic way. The petroleum fields in the provinces of Nazanderan, Gilon, Chamsee, Kerman Lauriston, and Arabiston are hardly touched, and render no profits worth mentioning. In those mountainous regions, naphtha is also said to exist in considerable quantities. According to Consul-General Hughes, experts on this subject believe that the two cities, Sohab and Schuschter, would serve best as central stations from which to work the fields. Sohab can easily be connected with the Dijalah River by means of a navigable canal, by a narrow gauge railway, or by pipe lines, so that the oil could be conveyed *viâ* the Dijalah and Tigris rivers to Mohammere without heavy freights. From there it would have to be transported by special vessels to India, Egypt, China, and Europe. The natural transportation route from Schuschter is along the course of the River Karun. The environs of Schuschter are particularly rich in petroleum and naphtha. At present nearly all the petroleum consumed in Asia and Africa (particularly in Japan, China, India, and Egypt), is furnished by the wells of Baku and Pennsylvania. Persian petroleum, with less cost for freight, could, it is said, doubtless compete successfully in neighbouring countries. The rich Persian coal veins are not properly appreciated. They cover wide regions, and are worked in a very primitive way. There can be no doubt that if vertical and horizontal shafts were driven into the veins, and the water pumped out, quantities of good coal could be brought to the surface. The Persians dig unsupported shafts, not more than 20 or 30 feet deep, and abandon them as soon as water makes the work difficult, reopening the vein at another spot. Only the surface coal is utilised. Copper, argentiferous lead, iron ore, arsenic, sulphur, cobalt, antimony, borax, tin and other minerals are also found in large quantities in the Persian mountain districts. All these resources must remain undeveloped so long as Persia possesses no transportation facilities. Even the well-known turquoise pits of Persia, the most important of which are those of Nishapur, in the province of Khorassan, yield so far very little good material, owing to the fact that they are owned by natives, who cannot work them by the modern system.

Correspondence.

TECHNICAL EDUCATION AS APPLIED TO PAPER-MAKING.

Owing to the lateness of the hour, and the necessity for catching a train, I refrained from making any remarks last night on Mr. Beadle's very able paper. I desire, however, to say that I think the City and Guilds Examination, as at present conducted, is a hindrance rather than an encouragement to young paper-makers, because the questions set are so largely coloured by the special features of the art with which the examiners are continually in touch during their daily routine work or professional business. As the mills are scattered over a wide extent of country, and many of them entirely isolated from kindred works, and as nearly every works has specialised its make, however well posted a youth may be in every detail of his art, he can have no practical or technical knowledge of it beyond the limited speciality of his own work's production. When a question is set involving a particular and intimate knowledge of some other branch he is quite non-plussed.

Moreover, the examinations, I think, tend to a policy of cram and smatter; they cover too wide a field at the expense of the fundamental principles underlying the various operations, which it is essential that the student should thoroughly grasp.

I submit that an immediate benefit would be reaped were the questions set more fundamental, and were questions which more properly belong to examinations in steam, mechanics, &c., omitted. At the same time, I think it cannot be too strongly insisted upon that no certificate should be granted, beyond a mere recognition that the student has passed certain of the examinations, till he has passed in at least three of the following subjects, besides paper-making proper:—Steam, Mechanics, Electricity, Chemistry, and Botany.

I am aware that this is simply an extension of the regulations now in force for obtaining the full Technological Certificate of the City and Guilds, but it is, I think, a much needed extension, and there are few mills where competent instructors could not be found for at least three of the subjects mentioned.

It is much to be hoped that, eventually, arrangements may be made to hold practical examinations with the experimental plant at the Municipal School at Manchester for all who may desire to obtain a full certificate, and that this may soon become an essential feature of the examinations.

J. MELROSE ARNOT.

153, High-street, Sutton, Surrey,
January 30th, 1902.

BENGAL—THE LAND AND ITS PEOPLE.

As an old railway engineer, I must take exception to Mr. Skrine's statement that the lack of sufficient waterways on railways is the cause of abnormally high floods. This is not the case; indeed, the railways are the greatest losers by these floods, which are mainly due to the futile endeavours made to keep deltaic rivers within their beds by riverain embankments. These bunds, so long as they are effective, cause the fertilising silt to be deposited in the beds of the rivers, instead of being spread over the land. The beds are thus raised, the bunds have also to be raised, and when they *are* breached, as they always are eventually, instead of a gentle and shallow spill, a roaring flood of great depth and velocity covers the ground with many feet of water and mostly with sand, owing to the strength of the current. For when the current is strong sand is deposited; when the flow is gentle, fertile soil has a chance of settling down. The railway embankments do not head up the waters half so much as the common roads, in which the waterways are practically non-existent, so that the floods rise until they flow over the roads, or breach them, and then come down with a rush on to the railway banks, the roads generally running nearer the river bank than the railways. It should also be remembered that a dam across a watershed, while submerging all the lands above it, saves those below it. In fact, I have had to cut such a dam, erected by the more powerful zemindars below, to the detriment of the weaker ones above it. This cutting, which was necessary in the interests of the railway, had to be effected by a subterfuge, so as to avoid a serious breach of the peace. As chief engineer of the Scinde, Punjaub, and Delhi Railway, I refused to contribute to the cost of a bund which was supposed to prevent floods in the Beas valley, across which, at considerable expense, we had constructed long viaducts designed to pass ordinary floods. I naturally objected to the maintenance of a work designed to stop ordinary floods at the risk of causing extraordinary ones, for which the viaducts were not designed. Mr. Skrine fully appreciates the value of local lines, or what are termed light railways, in India. It is curious that the native seems to have no initiative in starting these highly remunerative enterprises. By establishing an Association for promoting the interests of such lines, they might be encouraged to put their money into such projects.

ERNEST BENEDICT.

February 2nd, 1901.

IDENTIFICATION OF WOOD.

In reply to Sir Dietrich Brandis in the *Journal* of this date:—I will not say that "sneers" was the exactly fitting word for me to have applied in the *Journal* of the 20th ult. to the strictures passed by the lignologists present at the lecture by Mr. Herbert Stone on the "Identification of Wood" reported in the *Journal* of 6th idem: but in my memorandum on these strictures I quoted the "*ipsissima verba*," on which I particularly animadverted—in so doing, doing no more than Mr. Augustine Henry, who, as I read the report—for I was not at the meeting—stood up in defence of Kew against the specialists "in the study of wood," and did not, as Sir Dietrich Brandis, who presided, seems to imply, join in them—and, as a mere matter of controversy I should be well content to leave the matter there. Nevertheless, I warmly welcome the repudiation by Sir Dietrich Brandis of the significance I attached both to his spoken and unspoken attitude toward the strictures against which I ventured to protest; and I sincerely regret that I should have said anything about them which, in his consideration, misrepresents his real views, sentiments, and opinions on them.

GEORGE BIRDWOOD.

Candlemas Eve, 1902.

Obituary.

SIR CONRAD REEVES.—The Hon. Sir William Conrad Reeves, Chief Justice of Barbados, whose death took place on the 8th January last, was elected a member of the Society of Arts in 1897. He was born at Barbados in 1838, the son of Thomas Phillips Reeves, a medical practitioner, and he began life in a printing office, afterwards becoming a reporter.

His ability was so marked that his friends sent him to England to read for the bar. After he had been called by the Middle Temple he returned to his native island, and soon acquired a considerable practice as an advocate. In 1873 he was elected to the House of Assembly, and in 1876 he was appointed Solicitor-General. In 1881 he became Attorney-General, and in 1886 he was advanced to the Chief Justiceship. The Hon. Sir John Worrall Carrington, Chief Justice of the Supreme Court, Hong Kong, in a letter to the *Times*, described Sir Conrad Reeves as "the most distinguished man of colour ever born in the British dominions." On his death the Governor, with the consent of the members of the local legislature, accorded him the honour of a public funeral.

General Notes.

WIRELESS TELEGRAPHY. — The Commissioners of the Northern Lighthouses have decided (according to the *Engineer*) to adopt wireless telegraphy as a means of establishing communication between the mainland and certain of their lighthouses. The first installation will be at the Flannan Islands, which are situated about sixteen miles outside the west coast of Lewis. The installation, which will be made in conjunction with Lloyd's shipping agency, will be on the Marconi system. The Flannan Islands are practically the first land sighted by vessels coming from America, and the new installation will, therefore, be exceedingly valuable in reporting the sighting of vessels. It will also be utilised in communicating with the lighthouse keepers.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

FEBRUARY 12.—"Industrial Redistribution and its connection with the Overcrowding Question." By WILLIAM LEONARD MADGEN. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside

FEBRUARY 19.—"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A. GENERAL SIR GEORGE WENTWORTH A. HIGGINSON, K.C.B., will preside.

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E. SIR OWEN ROBERTS, D.C.L., will preside.

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS. LORD RAYLEIGH, D.C.L., LL.D., F.R.S., will preside.

MARCH 12.—"The Utility of Alkaline Phosphatic Manures." By JOHN HUGHES, F.I.C. PROFESSOR HENRY A. ARMSTRONG, L.L.D., F.R.S. will preside.

MARCH 19.—"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

Dates to be hereafter announced :—

"Servia as a Field for Railway, Mining, and Commercial Enterprise." By EVERARD R. CALTHROP, M.Inst.C.E., M.I.Mech.E.

"The Rural Schools of France." By CLOUDESLEY BRERETON.

"Recent Work on the Photography of Colour." By SIR WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S.

"London Tramways." By J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E.

"Remains of the Greek Occupation of Sicily." By DR. J. LEON WILLIAMS.

"Photographic Surveying." By. J. BRIDGES LEE, M.A.

"Ceuta and Gibraltar." By MAJOR-GEN. JOHN F. CREASE, C.B.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

FEBRUARY 27.—"The Industrial Development of India." By NILKANTH B. WAGLÉ, B.A. The EARL of HARDWICKE will preside.

MARCH 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By THOMAS WILLIAM HOLDERNESS, C.S.I., Secretary, Revenue Department, India Office. SIR ANTONY PATRICK MACDONNELL, G.C.S.I., will preside

MAY 1.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

FEBRUARY 18.—"The French Canadian Relationship to the Crown." By W. T. R. PRESTON, Chief Inspector Canadian Government Emigration Agencies. LORD STRATHCONA and MOUNT ROYAL, G.C.M.G., LL.D., will preside.

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G.

APRIL 22.—"British Commercial Prospects in the Far East." By BYRON BRENAN, C.M.G., late H.M. Consul-General at Shanghai.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock :—

MARCH 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY. WALTER CRANE, A.R.W.S., will preside.

APRIL 8. 8 p.m.—"Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington. H. H. STATHAM, F.R.I.B.A., will preside.

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

CYRIL DAVENPORT, F.S.A., "History of Personal Jewellery from Prehistoric Times." Three Lectures.

LECTURE I.—FEBRUARY 10.—Primitive NECKLACES of shells and trophies—Torques—Assyrian and Egyptian necklaces, Greek, Roman and Etruscan—The "Diamond Necklace"—BRACELETS among savage nations and in India—Early Egyptian bracelets found at Abydos, and those found at Mycenæ, Troy, and the Crimea—DIADEMS from Troy and Mycenæ—Fillets worn by Roman Emperors, and Etruscan wreaths of gold—Byzantine circlets and crowns and the British crowns.

LECTURE II.—FEBRUARY 17—EAR RINGS, nose-rings, toe-rings, lip-rings, and finger-rings—Ecclesiastical, royal, and military rings—Posy and gimmal rings and ring anecdotes—Mediæval talismanic rings, mourning, puzzle, and watch rings.

LECTURE III.—FEBRUARY 24—BROOCHES and their development from pins—The Celtic pen-annular brooches, Merovingian circular and rectangular brooches and their derivatives—Buckles—Roman and Greek fibulæ—Scandinavian and Anglo-Saxon brooches, with cut garnets and niello work, and the heavy boars-head brooches from Gotland.—PENDANTS as separate ornaments—The symbolical ornamentation of jewellery, swastika and triskele—Precious stones—Processes—Modern work—Summary.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.
March 3, 10, 17.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures.
April 14, 21, 28, May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 10...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Cyril Davenport, "History of Personal Jewellery from Prehistoric Times." (Lecture I.)

East India Association, Westminster Palace Hotel, 4 p.m. Mr. J. B. Pennington, "The Indian Civil Service and the Further Admission of Natives of India."

Imperial Institute, South Kensington, S.W., 8½ p.m. Sir Horace Tozer, "The Coloured Races in Australia."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the papers read by Mr. A. Dudley Clarke and Mr. G. S. Mathews, "The Final Report of the Local Taxation Commission."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. F. Gadow, "Protection by Shape and Colour in Amphibia and Reptiles."

TUESDAY, FEB. 11...Cyclists' Touring Club (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Metropolitan District Association (Motor Cycling Section).

Royal Institution, Albemarle-street W., 3 p.m. Dr. Allon Macfadyen, "The Cell: its Means of Offence and Defence." Immunity. (Lecture V.)

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. G. C. Buchanan, "The Port of Dundee."

Photographic, 66, Russell-square, W.C., 8 p.m. Annual Meeting.

Pharmaceutical, 17, Bloomsbury-square, W.C. 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Hon. J. H. Turner, "British Columbia of to-day."

Asiatic, 22, Albemarle-street, W. 3 p.m.

WEDNESDAY, FEB. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Leonard Madgen, "Industrial Redistribution and its Connection with the Overcrowding Question."

Sanitary Institute, 74A, Margaret-sreet, W., 8 p.m. A. Wynter Blyth, "The Prevention of Small-pox in the Metropolis."

Sanitary Engineers, 19, Bloomsbury-square, W.C., 7 p.m. Mr. W. E. Markham, "The Application of Disconnection."

Entomological, 11, Chandos-street, W., 7 p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

THURSDAY, FEB. 13...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. A. Cox, "The Glee in English Music."

Royal Institution, Albemarle-street, W., 3 p.m. Rev. John Watson, "The Scot of the 18th Century." (Lecture II.) In Kirk.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Prof. W. F. Barrett and Mr. W. Brown, "Researches on the Electrical Conductivity and Magnetic Properties of upwards of 100 different Alloys of Iron." 2. Prof. W. F. Barrett, "Some Conclusions deduced from the preceding Paper."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, FEB. 14...United Service Institution, Whitehall-yard, 3 p.m. Mr. G. Shee, "Advantages of Compulsory Service for Home Defence, and Some Objections."

Royal Institution, Albemarle-street, W., 3 p.m. Weekly Meeting. 9 p.m. Major P. A. Macmahon, "Magic Squares and other Problems in a Chess Board."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. C. Johnston. "Some Public Health Aspects of the Question of Sewage Disposal."

Astronomical, Burlington-house, 5 p.m. Annual Meeting.

Clinical, 20, Hanover-spuare, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Annual General Meeting. 2. Address by the President, Prof. S. P. Thompson. 3. Mr. T. H. Littlewood will exhibit an Atwood's Machine.

SATURDAY, FEB. 15. Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Some Electrical Developments." (Lecture I.)

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FRIDAY, FEBRUARY 14, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, February 17, 8 p.m. (Cantor Lecture.) Cyril Davenport, F.S.A., "The History of Personal Jewellery from Prehistoric Times." (Lecture II.)

Tuesday, February 18, 4.30 p.m. (Colonial Section.) W. T. R. Preston, "The French-Canadian Relationship to the Crown."

Wednesday, February 19, 8 p.m. (Ordinary Meeting.) Eric Stuart Bruce, M.A., "The Use of Balloons in War."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 10th inst., Mr. Cyril Davenport delivered the first lecture of his course on "The History of Personal Jewellery from Prehistoric Times."

The lectures will be published in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

COLONIAL SECTION.

Tuesday, January 28, 1902; Sir Henry M. Stanley, G.C.B., in the chair.

The Chairman, in introducing Commander Whitehouse, said that he had distinguished himself greatly in the survey of the Victoria Nyanza lake. It would also be interesting for the audience to know that the reader of the paper was a brother of Mr. George Whitehouse, the chief engineer of the Victoria Nyanza Railway, who lately received such a remarkable eulogy from Sir George Taubman Goldie in *The Times*.

The paper read was—

TO THE VICTORIA NYANZA BY THE UGANDA RAILWAY.

By Commander B. Whitehouse, R.N.

The Chief Engineer of the Uganda Railway and his staff arrived at Mombasa on 11th December, 1895; plate-laying began on the mainland on 5th August, 1896, and the first locomotive reached the lake shores on 19th December, 1901. So little has been said about this railway that few people have any idea of the circumstances under which it has been built.

When the first survey parties arrived there was a great scarcity of water on Mombasa Island. Consequently condensing plant had to be telegraphed for and worked steadily without ceasing for four years. Harbour works had to be built at Kilindini. Except for caravan work and survey parties there was no local labour obtainable. Emigration under contract from India to East Africa is not permitted by law, but a special Act allowed the importation of twenty thousand men from India, principally Punjabis, all of whom had to be supplied with food from their own country. While in the low country officers and men suffered greatly from fever, and small-pox often appeared. The engineers' strike in England made it difficult to obtain material and locomotives. Officers had to learn the two languages in use on the line. Famine among the natives lasted for nearly two years. The line had to climb to a height of 7,900 feet at mile 355 at the Kikuyu

Escarpment, then descend to 6,000 feet at mile 430 at Lake Elmenteita, had to again climb to 8,320 feet at mile 490 on the Mau ranges, descending to the lake at a level of 3,726 feet above the sea at mile 582 over a route for most of the last 100 miles that previous to September, 1898, no European had ever trodden. Never before has a railway been built under such extraordinary conditions or caused such radical changes in the country through which it has passed. Till other railways are constructed the whole of the trade of that part of Central Africa must come to it. The way the country has been opened up by it is very marked; rupees are in constant use where previously only beads, cloth, and wire were asked for. The journey from Mombasa to Port Florence, on the opening of the whole line, will take two and a half days, and another day can be allowed for the steamer journey of 148 miles to Mengo, the capital of Uganda—three and a half days, instead of about seventy by the old caravan route. All the privations, delays, and trouble of the caravan road are things of the past, and travellers now pass through the country in a first-class sleeping carriage at a charge of threepence per mile, with rates for their goods that compare most favourably with some of the other railways in Africa. Cable messages can be sent from any station on the railway, and a telegraph line has been laid into Uganda from Port Florence by the Railway Telegraph Staff. It was curious to be told within hearing of the sound of the Ripon Falls that "Lord Roberts had just taken Pretoria." It was also convenient to be able to contradict the news of my own death received about the same time.

The line of the railway is laid along the shortest route from the port of Mombasa to the most eastern point of the Lake. It is also on the shortest route to the first proposed terminus at Port Victoria. Between Port Florence and Port Victoria there are no great obstacles in the way of further extensions except the Nzoia River, which would have to be bridged in any case. When Port Florence was first visited by the railway survey parties in 1898 the Kavirondo tribes on each side of it were having constant fights on a small scale. The only intercourse was carried on by women, who did all the trading. The tribe inhabiting the Nandi plateau, about 2,300 feet above the Lake, occasionally descended on the Kavirondo people, cleared up a village or two, and drove off as many cattle as possible. On one occasion the surveyors, wishing to make arrangements through the Protectorate officers for buying up a village that the centre line cut through, afterwards found that the Wanandi had saved them the trouble, the village having disappeared in the interval. Hill tribes here, as all over the world, are more warlike than the people in the plain, but now they are all beginning to understand that they must behave better.

Beyond the great additions to the knowledge of the country from the actual surveys for the line, the whole of the coast line of the British half of the Victoria Nyanza, with all the islands that are known to exist in it, has been surveyed, under the superintendence of the Chief Engineer of the railway. This work was found to be necessary owing to the discovery in 1898, from the railway surveys, that the east side of the Lake differed very much from what it was supposed to be.

In Sir Henry Stanley's memorable journey of 1875, he visited a bay which he called "Ugowe Bay," and this was looked on as the most eastern point of the Lake. Sir Henry had, of course, very few opportunities compared to what the surveyors sent out by the railway had; his expedition being carried out under much more difficult circumstances. After our survey specially equipped for the purpose, I can gladly testify to the fact that his journey round the Lake in a small boat was a most venturesome piece of exploration, and not the least part of an altogether remarkable journey. The narrow and land-locked entrance of the great gulf of Kavirondo was evidently passed by him without being noticed, a thing remarkably easy to do when travelling in a small boat as he was. Later, the name "Ugowe" was wrongly given to the gulf at the head of which the railway terminus now is, and the Government station on the west side of Port Florence was called Port Ugowe; this caused a good deal of mystification.

In June, 1898, a large caravan was despatched from Kilindini by the Chief Engineer, for the special purpose of exploring the route between Lake Nakuro and Port Florence, or, as it was then called, Ugowe Bay. This expedition was given the most precise instructions as to the direction the new route was to be attempted.

No information concerning this route was available anywhere except from the maps of Col. Macdonald's surveys, and of the late Col. Vandeleur, Scots Guards, whose map of Nandi we had with us. Capt. Smith, R.E., had looked from distant hills over some of the valleys we traversed, but his map was not ready, and when we crossed that part of the country the latest maps showed it a blank. During the reconnaissance the weather was very wet, and all the rivers were difficult to cross. The expedition marched to Nandi and down to the head of the so-called Ugowe Bay, from which it proceeded on September 1st across the Kavirondo Plain and into the hills, arriving on the summit of Mau on September 13th. The only people we had any communication with during the march were some Wanandi, on entering the hilly country; and it was not possible to get many names of places. For several days we had marched towards a dark wooded hill close to the summit, which, on being passed, was named Mount Blackett, after the leader of the expedition. Descending to the plains, the caravan broke up on September 15th. The military police and all useless men were sent down country. Mr. Blackett and Dr. Brock, the medical officer with the expedition, proceeded over the old survey route to compare it with the one just discovered, while 83 men went with me as rapidly as we could up the road to Nandi, where the steel boat already left there was picked up and taken on to Port Victoria. I met Mr. C. W. Hobley on reaching Mumias, and he then very kindly gave me a copy of his map published by the Royal Geographical Society, in October, 1898. He had discovered that the coast between Port Victoria and Port Florence differed from what it was thought to be, but unfortunately he missed Ugowe Bay, and the Kavirondo Gulf was still shown as a large open bay, and still called Ugowe. What he thought were islands was really the mainland of Kasagunga and Kisingere—a very easy error to make from the other side of the gulf, especially if the weather was at all misty. Directly the Chief Engineer heard that the reconnaissance had succeeded, he came up country as fast as possible with Mr. J. R. Baas, Superintendent of Surveys, and Mrs. Whitehouse accompanied the party. The three parties met at Port Victoria on October 23rd, 1898, just as the steel boat *Vice-Admiral* was ready for work. Port Victoria was examined in case the terminus should have to be built there. Then the Chief Engineer went round in the *Vice-Admiral*, examining and mapping the coast all the way to the present terminus. The rest of the parties marched overland, and we all met at Port Florence on October 31st, 1898. The caravans went on to Kitoto's to buy food for the march over the new route, while the boat party visited Nyakach to examine Kach Bay. On landing, not knowing we were so close to the Miriu River (which I understand from Captain Gorges, Uganda Rifles, is the one he came down later in 1899 from Naivasha, and which the Walumbwas call the "Sondo"), we climbed the nearest hill to see what the coast line looked like. On our way we heard the rush of water, and found the Miriu River in high flood. The people were greatly surprised to see us, but were very amiable. We returned to Port Florence, and on November 3rd, 1898, the Chief Engineer marched to Kitoto's and accompanied the other parties over the new route. Survey parties were despatched to it directly after his return to head-quarters, and trains are now running along it.

After the survey of the future port was completed, the *Vice-Admiral* was taken back to Port Victoria. From the hills near the Miriu River we had seen that there was apparently a continuous coast line right up to Homa.

I should say here that on my return to headquarters I found a copy of Mr. Gedge's map giving Mr. Jackson's route to Uganda in 1890, and this shewed Homa as a point of the mainland. Wishing to be quite sure, the boat instead of returning along the north shore was taken south from Ndere Island towards two very conspicuous trees on the opposite shore. That night we camped at Homa Point, the people being quite friendly. Next day the boat crossed Homa Bay to Soklo, in Usau, and as the coast line was getting most interesting it was decided to stop there, so that a good view could be got from the summit of an adjacent hill. Most fortunately a man called Katizai was found here, who had once been in a caravan to the coast, and knew a little Swahili. He was rather old but managed to get to the top of Sahanga Hill next morning, over a thousand feet above the lake. Then it was found that instead of being an open bay with a mouth twenty miles across, we were in a land-locked gulf forty miles long, and that the so-called islands were mainland with hills towering over 3,000 feet above the Lake. Close behind were the Ruri Hills, afterwards visited and found to be about 1,800 feet above the Lake. North was the Kakanaga Range with Gembe Peak, afterwards visited and found to be 2,488 feet above lake level. West of that was the Gwasi Mountain, afterwards one of the main points of the Lake Survey, and found to be 3,370 feet above the Lake and the highest hill on the

British shore. East was Homa mountain, its northern conical peak, over 1,700 feet. Hundreds of villages were in sight, and to the south countless bush fires showed the presence of natives in great numbers. At the head of Homa Bay were two conical hills, called Simenya and Asago, afterwards visited, and Ugemi, the district they were in, found to be an exceedingly fine one. Inside Homa Bay was Ruri Bay, and at the head of it and below us sprinkled all over Usau, were many curious little conical hills from 200 to 700 feet high. Nearly forty miles to the north-east was Port Florence, with the steep Nandi escarpment behind it. North was the entrance to the gulf, almost shut in by a very curious looking island, Rusinga; beyond that again was the conical hill "Serawongo," 470 feet, noticed by Sir Henry Stanley in his voyage, and afterwards an important trigonometrical station in the survey. Further north, were the hills of Inyala, over the Government station of Port Victoria, with the Samia Hills to the east of them, while to the west lay many islands. Katizai, the old traveller, pointed out his chief's village, and then gave us the names of all the districts and their chiefs; after they had been checked at dozens of other places, more than a year later, he was found to have made only one mistake. Passing on up the coast, the mouth of the gulf was crossed, and the second entrance to it, Mbita Passage, only 280 yards broad, and afterwards a favourite camp, was sketched in. As we were travelling with orders to return with the greatest despatch, Ugowe was not then found, but a bay as we passed was seen to be much larger that when sketched in during misty weather on our trip down, and noted for special examination later. We marched from Port Victoria across country to Port Florence and Kitoto's. Lake Gangu was reached on the first day, and we camped by a curious heap of rocks, called Ndere, just east of it. Meeting Ugada, chief of Usakwa, at his village, I offered to take his son Obamba to the coast; as he spoke Swahili very well he was most useful everywhere, aud was certainly the smartest native I met in Africa. On arrival at Kitoto's, there were too many sick men in the caravan to attempt the rivers and hills of the new route, so the loads were sent up to the caravan road at Nandi, and food was bought for the journey down at Rongo villages on the Umbe River, a little east of Kitoto's kraal. The people became very friendly, and as it was Christmas time we organised the first athletic meeting ever held in Kavirondo. A big store was afterwards built by the railway just across the river, and food supplied to our survey parties for many months. Kitoto, said to be once the head chief of Kavirondo, is an avaricious old fellow, with very little authority over his people, in fact, on all the Lake coast of Kavirondo the chiefs have little power, and every man seems to do what is right in his own eyes. Finding a better road up to Nandi than we came down, we marched up there and so down to railhead, then at Kimaa, mile 264.

The Lake survey was commenced at the end of 1899, and it cleared up all geographical questions concerning the coast line in British territory. The survey was carried out in thirteen months, during which about 2,200 miles of coast line was mapped. Life at the Lake was then very different to what it had been. Survey parties were close to, the telegraph wire was at Port Florence, and was being laid into Uganda headquarters; a big caravan under Mr. Barton-Wright, assistant-engineer, was carrying up the three thousand loads of the steamship *William Mackinnon*, and engineers were building her. We went by train to the Kikuyu Escarpment, and by mule cart to Molo, being taken on by porters from Molo over the new route. If anything was wanted it could be telegraphed for, and when we returned to our head camp we generally found mails waiting for us. A great amount of information was obtained about the new country south of Kavirondo Gulf; and a warlike tribe, the "Kisi," inhabiting that part marked in the map Kosova, were heard of by that name for the first time. All round the coast, from Nyakach to Kadem, natives pointed to the same direction, and spoke of this tribe as they do of the Wanandi. Gembe and other hills near it, over 2,000 feet, were ascended, and also several more in Utegi, Karungu, and Kadem. Cairns were left on most of them, as well as on Pyramid Island in the Ugingo group of islets.

I had never been able to find any one who knew "Ugowe," though asking for it on every possible occasion. Kitoto himself said that there was no such place anywhere near him; Obamba, when passing Lake Gangu on our way from Port Victoria, pointed over to the west, and said "That is Uhandas." Most unfortunately he was not asked the usual question—"Is that the chief's name or the name of the district?" This should always be done, as name of chiefs are often given to districts by mistake. It was seen by this time

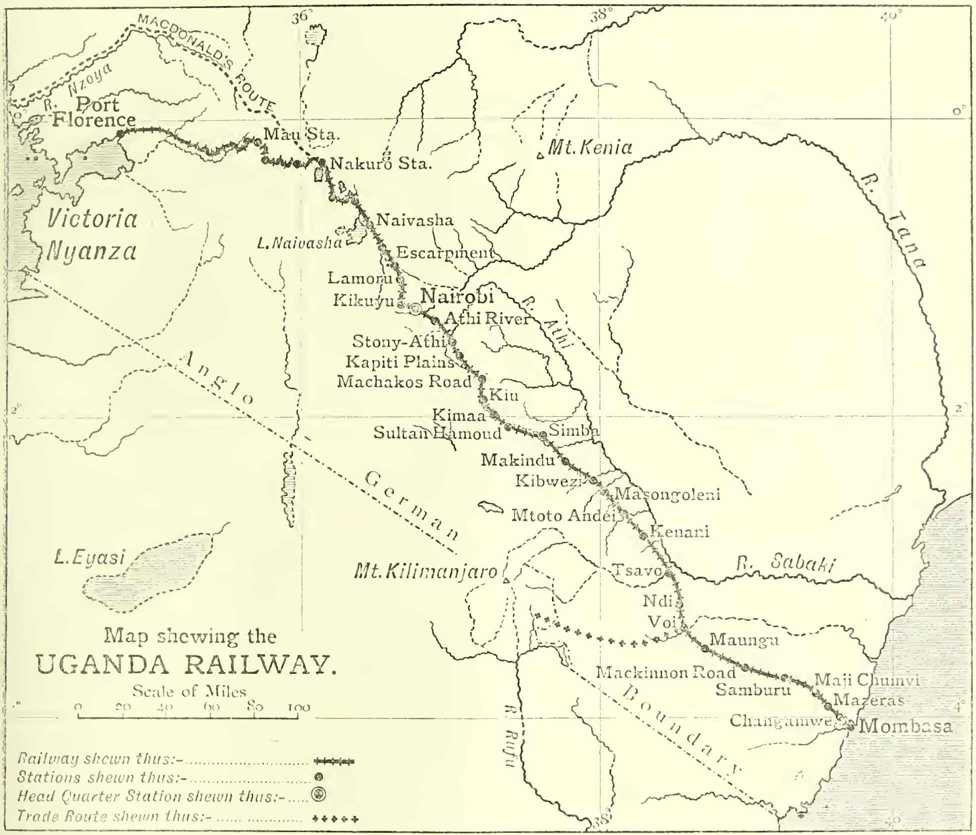
Ugowe could not be at Port Florence. When going north to Port Victoria, I sent for some Usakwa people at Uyawe, and with my interpreter and the head man of Uyawe, named Akeni, who spoke Swahili very well, asked them where the mouth of the Yala was. They replied that it was further up the coast. Then they were asked, "What is the name of the place where the water of the Yala passes into the Lake?" They all said, "Ugowe." We went on next day to the biggest bay in Kadimu, and camped on its south shore. In the evening Utonga Hill was climbed to get a view. Natives from it pointed out the district boundaries of Usakwa and Kadimu. The district Kadimu, must be Sir H. Stanley's Nakadimu. Next day we went to see the Yala River. Natives said it was two hours' march; it turned out to be three hours' and half hard walking. We covered, there and back, a distance of twenty-two miles. Passing the head of the gulf, all the natives said there was no river there, as shown on the old map. It was thought they must be wrong, but they insisted and said the river mouth was further up at Ugowe. To show we really had been to the river, it was photographed up stream and down. As we were leaving, a man came up and I asked him for some of the names of the villages round; he spoke Swahili, and said, "I remember you; you are the master of Obamba, and I am his friend. My name is Uyo, and I saw you often at Inyala with Mr. Foaker." It was very nice to meet an acquaintance in such a place. Next day we camped inside Usangi Hill at a place called Nangera. Mr. Hunter's report that there was no river at the head of the big bay was very puzzling, but natives said the river was just round the other side of Usangi Hill at Ugowe. The interpreter and some people from the villages were taken up the hill in the evening. On getting close to the top we were astonished to see a big lake below us. "This is Ugowe" said the interpreter, "the Yala River comes round that hill; there are the villages of the Ugowe chief, and there is the water of the Yala, passing to the lake." The people with us confirmed all this. As usual, to show that there was no mistake about our having been there, the camera was put up, and photographs taken all round the compass. Next day we went to Ugowe, and landed by the mouth of the river, which was full of fish traps. The chief came to see us and said he knew me. This was surprising, but he explained, through the interpreter, not having much Swahili himself, that he had seen me "building a dhow," with Mr. Foaker, a Protectorate officer at Inyala. We asked his name, he replied "Uhanda." He said he knew Obamba, and that he had gone with me to my country. On asking the name of the place, he said "Ugowe." Asked if it was all Ugowe, he replied, "No, only just here, this is all Kadimu;" and every name we had heard was verified over again. We told him we were very pleased indeed to meet him; that we had been chasing him and his country for the last two years, and now having found him intended to hand him down to posterity. The camera did the rest. We arranged with him to pass the *Vice-Admiral* through the fish traps in the river next day, and she was taken round Ugowe Lake. Then thinking we could see the Yala River from the top of Ramogi Hill we went up there, and found there was another lake the east side of it, called Ramboyu. Hearing the Yala River did not run into that, we went round Ramboyu Lake determined to find out where the end of the river was. After a long walk over the hills to a place called Ndiwo, we saw where the river ran into the swamp. Ramboyu, Ugowe, and Gangu, appear to be open places in the same swamp.

On reaching Fort Victoria, I sent for Namoja, the chief of Inyala, and the chief Govedo, otherwise known as Fisi, who lived close to the old Government station, and asked them if they knew where Ugowe was A crowd of people came with them, and many of them spoke Swahili. They chattered together, mentioning the name of the last officer at Port Victoria; then one man asked if I meant the place the white men had gone away to. The question was repeated, and they all said they did not know any place called that. Then I asked if they knew the name of the place the white men had gone away to, and none of them did. Then if they knew a man called Uhanda, and they all did. Where did he live? "In Kadimu." What was the name of his villages? "Ugowe." Then they were asked why they were such foolish people as to say their friend lived at Ugowe, in Kadimu, after they had just said they did not know where Ugowe was? The chief said, in an injured tone, "That place is close to; we thought you were talking of some place far away." As usual, to make sure, I went up a hill near the old Government station, and took a photograph of Ugowe Bay in the distance, as well as the panorama of all the coast north and south. As there still seemed to be doubt in some minds that we had found the place visited by Sir H. Stanley, on our way back to Fort Florence at the end of the survey we visited two small islets north of Rusinga Island. We had never found Sir H. Stanley's "Bridge Island," from which he proceeded northward to Ugowe Bay. If a natural bridge could be found at these islets I knew it would of course settle the question for good, as to get to Port Florence he would have had to go south-east instead of northwards. We had a good breeze out to the islets from Uyawe, and to show that there was no doubt about our having been there, a photograph of South Bridge Island was taken, showing the natural bridge and stopping all further argument. It also shows that there are hardly any trees left on it. The islet is 40 to 50 feet high, and was covered with birds' nests, mostly those of cormorants. On examination the cave reported on the other islet was also found to be an arch. There are a great many natural arches on the Lake; one smaller one quite close to Entebbe.

The weather on the lake is often very misty, but when clear, objects can be seen at a very great distance. From Gembe Peak 2,488 feet above lake level, angles were taken to the big tree at Bagete on Buvuma Island, which was plainly seen with the theodolite telescope at 78 statute miles distance. This tree was afterwards visited. Precautions were taken on landing in Buvuma, as the natives have a bad character. A crowd of from 400 to 500 soon gathered, and many more were seen streaming in from all directions over the hills. These interesting people looked very truculent, and their well-known expertness with slings and stones is visibly stamped on the heads of many of them. Of the nearest fifteen, no less than twelve had their heads battered in, the scar generally taking the shape of a large Maltese cross. An old stone fort was found on the top of Ndwasi Hill in Bugaia Island, which had evidently been built as a place of retreat from the Wavuma. Other defences were seen on many other islands, but this was the largest, and having many storehouses in it, was quite capable of standing a siege if put into order. The chief of Bugaia said it was a very old fort.

To go back to the railway, as already said, the want of water was very serious during construction up to Voi; it is different now, as water is pumped up from the Mwachi River, some distance from the line to Mazeras Station, mile 16. A pool of water was found by the surveyors above Maji Chumvi Bridges, formed by a natural ledge of rock lying across the bed of the stream; it was very brackish but better than nothing. There was no more water till the Taru Desert was crossed, but a small pool sometimes existed on the top of a rocky hill at Maungu, mile 83. There was another pool on a higher hill some distance to the south. Soon after the line reached Voi River, which according to all accounts never ran dry, it got perfectly dry, but water was obtained from the swamp above the bridge, one mile beyond the station. The Church Missionary Society have a station on the Sagalla Hills, called by caravan porters, the Ndara Hills. The next water used was that of the Tsavo River, mile 133. This river runs in a great hurry, and joining the Athi River below the bridge, forms the Sabaki River, which runs into the sea a little north of Mombasa. It was at Tsavo that two lions created such a panic by carrying off twenty-eight coolies; the number of Africans killed not being ascertainable. The line from here is very uninteresting. If passed during the day, the snow-capped mountain Kilimanjaro is often seen to the south. Several small streams which occasionally run dry are crossed, but at Kibwezi, mile 195, there is a pretty little river running through an artificial bed made by the Scottish Mission, which has now moved its quarters to the Kikuyu Hills.

After leaving Kibwezi, the grey thorny bush becomes more open. Game of all description is constantly seen close to the line. From the Tsavo River to the Kedong River, except within a ten-miles circle from Kikuyu Fort (an old Government station, now given up) the railway runs through the Game Reserve of East Africa. Beasts of prey can be shot on the railway limit (that is a mile each side of it), and a reward is paid for every lion shot between certain stations. This reward of 100 rupees is given as lions have caused much trouble on the line—the worst case being that of Mr. Ryall, the Acting Superintendent of Police of the Railway. A lion had become a confirmed man-eater at Kimaa, mile 257. Mr. Ryall, travelling with two other gentlemen, had his inspection carriage cut off at Kimaa, on purpose to try and shoot it. As the story has already been told, and is a very dreadful one, it will be enough to say that the lion got into the carriage in the night, killed Mr. Ryall without taking any notice of the other two gentlemen; and the door shutting (the slightest push would be sufficient to close the door), it carried off Mr. Ryall through one of the windows. A reward of £100 was at once offered for the man-eater, and a lion was afterwards caught in a trap by Mr. Costello, of the Makindu Locomotive Staff. As further trouble ceased with this capture the reward was paid for it. Passing travellers have thought on some occasions that all the game had disappeared from the Athai Plains. My experiences are quite different. For the last five days I was at Nairobi I went out to shoot a little meat for some of the men who had been up at the Lake with me. Coming over the plains in the train from Nairobi, we saw a vast number of Thompson's gazelle, several herds of harte-beest, about twenty ostriches, dozens of bustard, and a good many wildebeest; a cow giraffe and her calf were on the Athi River just below the bridge. I was told that two days before I got there, five lions had crossed the line at the down points of Athi River Station, early one morning. The men in charge of the pump by the river told me that a lioness and two cubs had crossed the down end of the bridge the night before. Within five miles of the station, I shot what I wanted without trouble, seeing wildebeest, hartebeest, Grant's, Thompson's gazelle, and Impala in great numbers, as well as five hyenas and several ostriches. Plenty of lions were heard every night, while close to where I was were herds of some thousands of zebra. I also got twenty-five sand grouse, five spur fowl, and three bustard; there are plenty of fish in the river, very like mahseer, and they give good sport with light tackle and a gold and silver spoon. The morning I went back to Athi River Station, a lioness was shot near it by a visitor from England. Considering this place was at the edge of the reserve, and within very easy reach of Nairobi, game has evidently not quite disappeared. The game laws are now very strict; a game licence for a Government officer costs £10 a year, the number of animals allowed to be shot being limited. Settlers, traders, and missionaries also pay £10 a year for still more limited numbers. Visitors who come to shoot have to pay £50 for a limited number of beasts in each Protectorate. Many


Map shewing the UGANDA RAILWAY.

Walker & Cockerell sc.

species are protected altogether, and there are many restrictions that intending sportsmen should make themselves familiar with before going there. There are a large number of rhinoceroses in places along the line. As a rule they do not interfere with travellers that let them alone. In some cases, of course, they are dangerous, but it was easy to get close to many for photographs. One long hunt was made on purpose for this, and nineteen photographs were taken, as it was thought most successfully, some at a distance of 12 yards from behind a tree. On opening the camera at night it was discovered that the mechanism had not acted, and the nineteen beautiful pictures were all on the first film. It is often said that a rhinoceros will charge the person that he gets the wind of; such is not my experience. I walked close up to the first I saw by accident—a cow and its calf. They certainly got my wind at a distance of less than 20 yards, but after looking at me for a few seconds they both bolted. On another occasion, on the Athi Plains, one came up towards us, and, stopping less than 200 yards away, watched the caravan go by, with the wind blowing straight from us to him. Probably he was used to seeing Masai and other natives, and rhinoceroses in less frequented places might have been more dangerous. Two are allowed to be shot by license. It is very poor sport shooting them, but, like the hippotamus, they are a cheap present to gain the natives' good will in famine time. One shot at Kin was entirely eaten that day, and the next morning we found some poor starved creatures picking off what flesh was left on the head, and eating it raw. The famine along the line in 1898-9 was very bad, and it is hardly surprising that the starving people should have tried on some few occasions to get at the flour stores of the permanent way gangs. It must be dreadful to see a line of camps with plenty of food stretching along a famine stricken country and not to be able to share in any of it.

There are many different tribes along the line. The most useful people at present in Africa are the Swahilis, the Seedie boys of the men-of-war and the mail steamer. Most of them are Mohammedans; but they are not very particular in regard to their religion. Porters are drawn from many tribes, from Uganda right down to the coast. If they are kept any time inactive they get very lazy, and have to be hunted round before they will go to work again. The Swahilis are very good men for caravan and survey work. Great things were prophesied as to what the Masai would do to the railway when it reached their country; but they turned out to be the most amiable of all the tribes. Some of them are herdsmen to people connected with the line, and some of the boys become servants for a time, but I have never heard of any working on the line, and such work would be very much against their ordinary habits. They have not very good physique as a rule, and are far below the Zulu in that respect; those round Naivasha were the finest met with. The so-called Masai that were employed in guarding the telegraph wires in the Nyando Valley when we marched down on our return from the Lake, were the weediest looking natives I have ever seen in any part of the world, but it was said they were not real Masai. The kraals visited never gave any inducement to visit them a second time. The Wanandi are a very war-like race; the finest young man I ever saw in Africa was in Nandi; he passed us carrying his shield and spears, walking as if he owned the country and knew it. The Wakavirondo are dreadful cowards, with very few exceptions (such as Obamba). At any sudden movement they will scatter like a flock of sheep.

The climate of the country the line passes through from Sultan Hamoud Station, mile 238, to the lower part of the Nyando Valley, mile 550, is very pleasant. From above mile 33, bad nights such as have to be endured on the tropical coasts of Africa and India are never experienced. After more than four years' pioneering work, I consider the country between the coast and the Lake to be anything but unpleasant, and stores of all sorts can now be obtained along the line at very reasonable rates.

Coffee grows well in Sesse and Uganda, and rubber everywhere. Hardly any island was visited west of Buvuma, that had not Landolphia rubber vines growing on it. Very good fibre is grown in East Africa and Uganda. Castor-oil plant grows everywhere, and, if trees of it are allowed in gardens, they become a nuisance, as they spread so very quickly. Tobacco grows well, especially in Nandi, and is much used by all the people. Good crops of potatoes and all kinds of English vegetables can be easily raised round Nairobi. Uganda itself and Buddu appear to be very good agricultural countries, and Nandi certainly looks like a very fine planting country. Kikuyu will, of course, become settled in before Nandi, as Nairobi is the most important place in the country next to Mombasa. Its population is roughly about 5,000. There was no one there till the railway made its appearance, the head-quarters of the Ukamba province being then at Machakos, some distance to the south-east. Very good gardens can be made on the Kikuyu hills, and it is easy to irrigate them. Most of the potatoes used on the coast and in Zanzibar are said to come from France. There is no reason why they should not all be grown in Kikuyu, one day by rail from Mombasa.

Being right on the Equator the sun is, of course, very powerful. The best results seen on the Lake were obtained in a shaded garden. The produce was quite up to the ordinary English standard, and this, although the soil of that particular garden was certainly the poorest met with. A week's dry weather under such a tropical sun will do more damage than a month's dry weather in England. Irrigation from the east side of Mau ranges to the Kavirondo Plains would not be difficult; there are many streams, and Mau being the highest part of the country they are rarely dry, owing to the heavy rainfall and mists. There is enormous motive power running to waste at the Ripon Falls, and the river below it, which consists of rapids and cataracts for a considerable distance down. There are also several rivers along the railway route, which could be utilised in the same way.

Apparently there is no difficulty in getting cheap labour in Uganda by people who intend to stay among the natives for some time. The Wakikuyu are beginning to understand work —many of them are now used for breaking up ground and clearing forests. The ballasting of the line near Nairobi and all the drainage of the railway township have been done with native labour. No labour was obtainable at first, as the people knew nothing about it, but it seems that there will be a good deal available in the future. The occupation of the porter having gone he will soon be forced to labour for a living, and no doubt a considerable number will eventually take to work on the line. For further railway extension there should be a good deal of local labour procurable. Waganda would certainly work well in their own country on earthworks.

There is a good deal of fever, which is not surprising in a new tropical country in which before the advent of the railway living could hardly be called comfortable. From the worst kind, known as Blackwater fever, the engineers have been singularly free, for from among about fifty employed on the line for the last five and a-half years, there has been only one slight case; and yet they have been engaged in what is always supposed to be the worst thing for health in the tropics, namely, turning up virgin soil. White people appear to be generally safe from the small-pox the tribes occasionally suffer from. European children can live a pleasant life at Nairobi, and Mombasa itself has a pleasanter climate than Bombay.

The Lake region is a very stormy one, and a day never passes without thunder, while a storm can always be seen somewhere, although it never lasts long. During the first survey of Port Florence, in 1898, there were seventeen violent storms during twenty-one days spent there and tents were constantly blown down. This causes much sickness, which will not be case when houses are built.

The ideas of the Lake fishermen are very primitive; no nets were ever seen, fences of reed and grass are made on the shore, and at the mouths of all rivers, with traps at close intervals along them. These are visited at least twice a day. Fish-pots are also much used, and drift about in all directions, often several miles from the shore, and canoes visit them constantly. Very large screens of light reed work on the principle of the seine-net, and laid out with rafts are used with considerable success. A row of fish-pots takes the place of the purse. In Kavirondo they were never hauled right up on the beach as our seines are; the screen is brought very close in, and then men and women scoop about inside it, catching the fish in their baskets, and driving them to the centre part of the screen into the baskets fixed there. It is curious to see natives wading about with hippotamuses not far from them. In Uganda, Sesse, and Buddu a still more primitive screen of banana leaves is used exactly as a seine is. Ropes are well made of grass, which float on the surface, and many were seen over a quarter of a mile long. The screen is sometimes laid out and allowed to drift a long distance before it is finally hauled ashore. Dried fish is a great article of trade all round the Lake, but not likely to extend beyond its shores.

A curious point about the Lake natives is, that although they have fairly good canoes, they appear to be absolutely ignorant of sails. Only one mast was ever seen, and that was evidently an imitation of our boats, which always travelled with the masts up, and no sail was used on it.

Great crowds of insects can be seen on the Lake; they appear to hatch out of the water far out in the Lake, and come ashore before the southerly winds. The insects are rather less visible than the ordinary grey mosquito. Swarms were seen more than twenty-five miles distant, like the smoke of ocean steamers; at first they were taken for smoke from low islands out of sight, as they were seen on several occasions about the same spot; next they were mistaken for water-spouts, which are often seen on the Lake. A series of photographs of them were taken, but not very successfully. On the outer islands these insects are a great nuisance. The air is quite darkened with them as they drift past. The natives catch them by waving baskets round their heads, then collecting them from the bottom, they pound them up into a kind of rissole, and after exposing them to the sun for some time, eat them. We also on several occasions suffered from great swarms of what appeared to be the common May fly, particularly on one occasion at Luambu, the western island of the Sesse group, where they stopped theodolite work for some time. Mosquitoes were, of course, very bad in swampy places, but 1900 was better than 1898; the Lake in 1900 was at an extraordinary low level, and the shores, in consequence, were much drier, with fewer mosquitoes. The waters of the Lake at Port Florence have been referred to as stagnant; they are, of course, at rest, and more or less stagnant everywhere, except just at the mouths of rivers and narrow passages where the action of the wind causes currents, and at the Ripon Falls. At Port Florence the water is made worse by the hippopotamuses, and by the fishermen constantly stirring up the mud. In 1898 twenty-five hippos together, were often seen close to the boat at the mouth of the bay. It is a mistake to consider Port Florence any worse than many other places round the Lake. There are excellent building sites on the hills on the east side of the harbour. Kavirondo Gulf, with its narrow entrance, is naturally muddy on account of the rivers that run upon it—one of which the Ulambwi, was only discovered during the late survey. All the water of the lake near the shores is more or less muddy; it is quite muddy all along the west shore and between the Sesse group and Uganda. The head of Berkeley Bay is just as muddy as Port Florence.

On Mr. E. G. Ravenstein's map giving part of Sir Henry Stanley's route we found marked "Marija Islands reported by Stanley three miles east of Kiuwa not to be identified." They were identified at once from the mainland the first time they were seen—a chief was asked the name of some small islands and he said Marida or Marija; they were afterwards visited and found to be four in number, and to be just where Sir Henry Stanley put them, viz., three miles east of Kiuwa Island.

The Kagera River had apparently more water in it than the other rivers we visited, but it winds very much, and it will probably not be much used. The *Vice-Admiral* was taken about three miles up it. A steam launch, now wrecked, that belonged to an English firm, has been a considerable distance up it. No steam launch could go up any of the other rivers we saw.

The language of the country in the future will certainly be Swahili. The natives round the east coast are picking it up very quickly. We found many speaking it at Mbita Passage on our way back to head-quarters, but none could speak a word of it when they were first visited. Swahili is the most useful language in the country, and it seems to be a very good thing that its use is extending so fast, as the number of languages in use at present cause a deal of confusion to travellers.

DISCUSSION.

The CHAIRMAN thought the audience must have been impressed, as he had been himself, with two things in the paper, first, the vast variety of information it contained, and, secondly, the writer's abstention from any mention of himself. He had kept exclusively to facts other than personal. The other day he (the Chairman) was favoured with a peep at Commander Whitehouse's map, and he was struck with the fulness of its detail and accuracy. He took out his old note-books and then compared the rude sketches that he made as he went from camp to camp around the Victoria Nyanza twenty-seven years ago, with the details which Commander Whitehouse had put in his map; and whilst he was perfectly satisfied that his facts were right he was also struck with the workmanlike way in which the reader of the paper had arrayed his facts also. Mention had been made in the paper of Ugowé Bay. He remembered, when sailing from Bridge Island, that he came on a very spacious bay. Managing to get within about a hundred yards of the shore he saw a native and asked him what the name of the place was. He had to ask several times. Finally, in answer, he heard something which sounded like "You go away." He said to himself, "Why, this must be a Swahili who has fled from Zanzibar through committing some awful crime, and who has found shelter in this region." He again asked the man the name of the place, the man again replying, "You go 'way." Finally, he got the interpreter to say that all he wanted was the name of the place, and again the answer was given him, "You go 'way." Under these circumstances he was, of course, bound to accept the name; anyhow it would do very well as a landmark to indicate the place where the question had been asked, and it could be left for experts like Commander Whitehouse to come along some day and find out whether it was "U. G. G." or "You go 'way." Commander Whitehouse had let slip a sentence which had impressed him very much. He said in the paper, "The Lake region explored is a very stormy one, and a day never passes without thunder, while a storm can always be seen somewhere, although it never lasts long. During the first survey of Port Florence, in 1898, there were seventeen violent storms occurring within twenty-one days." On looking at the beautiful map shown by Commander Whitehouse he seemed to see the sailor, with his small crew and his little steel boat, wandering from point to point, crossing and re-crossing, going from an island to some headland, taking his bearings from that headland back again to the island and to some point far away; then a tornado coming down, with a torrential downpour of rain, and, perhaps, a storm of hail, which threatened to fill the boat; then a few hours later a sun so fierce that the sides of the boat became so hot as to scorch the hand if the boat were touched. As he looked at the map he thought to himself that Commander Whitehouse must have passed many anxious hours. He had said that he took thirteen months, during his survey, in which to delineate a coast line 2,200 miles in length. When twenty-seven years ago he (Sir H. Stanley) was instructed to go into that part of the world it was understood that he had to settle a question which very much vexed geographers at that time. According to Speke's theory that great lake, which now bore the name of the Victoria Nyanza, was one vast body of water, almost equal to the size of Scotland in area; whereas, according to Sir Richard Burton, it was only a series of small lakes or swamps. That was the problem he had to settle, and that was the cause of his circumnavigating the Lake. He carried with him a little sectional boat, built at Teddington-on-Thames, and after fifty-seven days' voyage, with numerous adventures, he came back to the point from which he had started. Even had he had the time to examine, more carefully, the inlets, bays, creeks, and gulfs of the Lake Victoria, he could never have hoped to lay them down with the remarkable accuracy displayed by Commander Whitehouse. He had always believed in thoroughness, and in the reader of the paper they had a remarkable example of that admirable quality. He remembered, twenty-seven years ago, that after rounding the southern side and the eastern and northern coasts of the Lake, and coming halfway down, just south of the equator, they were driven from the mainland by some cantankerous natives, and came to a small islet where at last they were perfectly safe from all harm and had leisure to reflect. Ascending to the highest peak of that little islet, he saw a boundless extent of fresh-water sea towards the north, east and south, while towards the west and south-west there was a magnificent extent of hitherto unexplored territory. He could not help but admire the scene, and he seemed to see as in a vision what would happen in the days to come. He seemed to see steamers trailing their dark smoke over the grey waters of the bay, loaded with passengers and natives about to exchange and barter at some well-established port, and the natives of Uganda, instead of looking with contempt upon the wild, savage Usukuma at the south, willingly coming down to exchange their coffees for the cattle of Usukuma, and shaking hands in all friendship with the natives they had formerly despised. He seemed to see the natives of the east coast making blood-brotherhood with the natives of the west coast; he seemed to hear church bells ringing at a great distance away; and he hoped and prayed that some day that vision might be realised. Twenty-seven years had passed, and he thought those present would admit they were on the eve of the realisation of that vision. In those days Mtesa, of Uganda, impaled his victims and clubbed his women to death upon the slightest provocation; the slingers of the islands stood ready to welcome the wayfarer or the traveller with showers of stones, and along all the shores visited by Commander Whitehouse, there was a group here and a battalion there, or an army at another place doing all the tricks common to barbarous people, and sighing and thirsting for blood. Those days had passed by. The missionaries had been labouring in Uganda, and could show ninety thousand Christian people. Three hundred and twenty churches had been established there, and there were many thousands of children at school. It was only the other day he received a letter from a man, at Mengo, saying there were five hundred children in the Mengo school every day. The converts of Uganda were actually carrying the Gospel to the distant lands ot the West. Toro had been made acquainted with the Gospel. Usongora, which was a wild and devastated country only twelve years ago, now welcomed the white traders; at Kavalli, where he rested, the people had begun to welcome the white men; and even the little Pigmies in the forest were holding out their hands to welcome the white people. Such had been the change wrought in twenty-seven years. Though it had been slow work, though missionaries had often felt depressed, broken-hearted, and dispirited, and had been expelled from Uganda, though the native converts suffered death and persecution, still the missionaries had persevered, and in the end had received their reward. They now knew that the terminus of the great railway was built on the very shore of the Lake; while one steamer, the

William Mackinnon, was also trafficking between Port Florence on the east and Entebbe on the north-west, and was but the precursor of a fleet of such steamers. In 1880, 1881, and 1882 he carried three small steamers on to the Upper Congo; to-day there were eighty, with a tonnage of about 10,000 tons. To-day there was only one steamer of seventy-five feet in length on the Victoria Nyanza. In ten years hence there would very likely be fifty, in twenty years 100, in fifty years 200, and that was the way civilisation would go on spreading out and stirring the people to activity. There were two main motives for which the British nation voted the money for the construction of the Uganda Railway. The first was the suppression of the slave trade, and the second was to effect an uninterrupted and speedy communication between the sea and what was called the "Pearl of Africa," and to-day, as the reader of the paper had said, those two objects had been accomplished. The slave trader could not now be found in those regions, otherwise the very sight of a white man would be fatal to him; while as for the uninterrupted and speedy communication, it only now required two-and-a-half days to reach Uganda from the sea, whereas it previously occupied months. Speke took nine months to reach Uganda; it took him (Sir Henry Stanley), eight; it took a missionary six; and the bravest and speediest traveller took three months. Now it could be done in two-and a-half days. If that lake region had advanced so marvellously as it had done during the slow period, when the laden porters carried the loads of the missionary, the sugar-chest of the trader, and the weights of the steamer up to Uganda, what would be its rate of progress now that Uganda was brought within two-and-a-half days of the sea? While congratulating themselves on what had been accomplished during the last twenty-seven years they should remember gratefully the services of the missionaries, and also of those wise men, like Sir Gerald Portal, who emphasized over and over again to the Government the need of the Great Uganda Railway to redeem the land. They must also recollect the sagacious administrators who had been sent to Uganda, who, by their tolerance and tact, had taught the natives wherever they went that the approach of an Englishman was a blessing to them.

Sir HARRY H. JOHNSTON, G.C.B., thought that one marked feature of Commander Whitehouse's surveys was his admirable relations with the natives. During the greater part of the time the reader of the paper was surveying the Lake, he (Sir Harry Johnston) was Commissioner in Uganda, and never once was he, or any of his colleagues working with him, called on to intervene to heal any breach of the peace that might have occurred between Commander Whitehouse and his men and the natives. Not that Europeans went about in the Uganda Protectorate seeking to make breaches of the peace, but so many of them were helpless as to what was done by their Swahili followers. The coast negroes or Swahilis were a very sturdy race and very useful to the Europeans, but they were so proud of their recently acquired knowledge of civilisation that they were apt to bully the natives. The bullying was carried on in a language not understood by the white men, and was very often the cause of trouble. In a vast number of instances the European was too ready to resort to arms, to punish natives for such breaches, when a little inquiry and a little patience would have shown him that his own men had begun the quarrel, and that the natives were willing to listen to arguments and accept any amends that might be made. Whenever he had subsequently visited places visited by the reader of the paper he had never heard anything but good of him in his relations with the natives. He thought Commander Whitehouse's survey of the Lake was truly remarkable for the enormous additions to their geographical knowledge, and, in a secondary way, in bringing natives who had scarcely seen a white man before pleasantly into contact with one for the first time, and opening the way for administrative action to follow.

Sir T. FOWELL BUXTON, Bart., G.C.M.G., thought there were two points in the paper which brought home the extraordinary progress made in the history of Lake Victoria Nyanza. In the first place, with regard to the railway itself, many present could remember the great interest felt in England, many years ago, in the journeyings of the then Mr. Stanley. He told them what the country was like, and what might be the result of good government and European leading. That Sir Henry Stanley should have been present, and occupy the chair, when his vision of twenty-seven years ago was fulfilled, was a most interesting occurrence. He hoped one point, especially in connection with the railway, would not be forgotten, namely, its bearing upon the slave trade and slavery. There was a time, no doubt, when the caravans were to a great extent composed of slaves. Honest wages were paid to the porters who carried the burdens, but when they came back again to the coast they were got hold of by their masters and owners, and to a large extent robbed of their wages. That state of things was at an end, and the habit of earning wages and labouring for payment would, he hoped, be extended over a large area. A picture had been shown of the cathedral at Mengo as it was a short time ago, with a portrait of the Bishop of Uganda. Bishop Tucker had shown him, a few days ago, some pictures of the new Cathedral growing up. The walls were 10 or 15 feet high, and 3 or 4 feet thick. The art of brick-making and laying bricks had been introduced into the country, bricks being previously unknown. That was a great sign of the progress made. While thanking Commander Whitehouse for his excellent paper, he thought the Chairman should also be congratulated on the progress which, to some extent, he foresaw, and which he had been permitted to see.

Sir GUILFORD MOLESWORTH, K.C.I.E., said he had one slight criticism to make. Sir Henry stated that Commander Whitehouse had been too humble in speaking about himself. He thought Commander Whitehouse had also been too hnmble in speaking about the wonderful way in which his brother had carried out the important work of the Uganda Railway. The work of constructing the railway presented unique difficulties, which no other railway in the world had had to encounter. The difficulties were extraordinary. There was an unknown country, then the newness of the staff, the want of water, the absence of all means of animal transport owing to the mortality caused by the tsetse fly, the having to establish everything, the policy of having to push forward the railway at any cost and at any sacrifice, so as to get through somehow or other. Then there had been the difficulty of lions, the difficulty of jiggers, which had ofted caused men to lose their toes; the fact that an army of 15,000 men cut off from its base of supplies, had had to be organised, the raising of an efficient police force, and fever in all directions. During his visit to the country he found that, out of a gang of 320 men, about 280 were down with the fever, and out of a set of eight drivers, seven were down with the fever. In addition, the engines had had to carry water, thus limiting their loads; they had had to go along temporary lines in which the curves were very sharp and the gradients steep, again limiting their work. The way in which these enormous difficulties had been surmounted by Mr. Whitehouse and his staff was deserving of the very greatest credit.

On the motion of the CHAIRMAN, a vote of thanks was accorded to the reader of the paper, to which Commander Whitehouse briefly replied.

The Hon. Sir JOHN A. COCKBURN, K.C.M.G., said that everybody present would carry away a most graphic picture of what they had seen, and what they had heard would long live in their memories. They had been admitted into the recesses of the arduous work of those who weaved at the loom of empire. They had heard how the vision of the practical man with the constructive imagination, which was everywhere the pioneer of their mighty empire, had been actually realised by a subsequent generation. He thought it would be safe to predict that the epoch into which they just entered, the reign of Edward VII. would be one of organisation of the vast territory which the Empire had acquired. They would ever remember with grateful pride renowned explorers like Sir Henry Stanley, who, at infinite risk to themselves, had made it possible for the engineer to follow in the track which they had pioneered, and make possible the vast achievements of which they, as members of one great world-wide community, had every reason to be proud. He concluded by moving a cordial vote of thanks to the Chairman.

Colonel HAYES SADLER (Commissioner of Uganda) seconded the vote of thanks, and expressed his sense of their obligations to the Chairman.

The resolution was unanimously adopted.

TENTH ORDINARY MEETING.

Wednesday, February 12th, 1902; SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Barron, Claud Alexander, I.C.S., Kohat, Punjab, India.
Frankland, Frederick William, New York Life Insurance Company, 346, Broadway, New York, U.S.A.
Gupta, Professor Manoranjan, B.A., Kalia, Jessore District, Bengal, and St. Andrew's College, Gorakhpur, N.W.P., India.
Milsted, W. P. S., Armenian College, Calcutta, India.
Seear, J., The Quarry, Cheam, Surrey.
Small, Professor James Willoughby, F.G.S., Victoria College, Jaffna, Ceylon.
Smith, Herbert Guildford, P.O. Box 73, Lowe's-building, East London, Cape Colony, South Africa.
Subbiah, P. V., Gopalasawmy Coil, North Street, Palamcottah, Madras, India.
Wallace, Alexander Falconer, 20 Hyde-park-gardens, W.
Watermeyer, Vipan Maitland, P.O. Box 398, Public Works Department, Pretoria, Transvaal Colony, South Africa.
Webb, John Frederick, 63, Queen Victoria-street, E.C.

The following members were balloted for, and duly elected members of the Society:—

Gallenkamp, Adolphus Charles, 19 and 21, Sun-street, Finsbury-square, E.C., and 106, Mount Pleasant-lane, Upper Clapton, N.E.
Keller, Francis, The Limes, Sarisbury-green, Southampton.
MacDonnell, Sir Antony Patrick, G.C.S.I., 186, Cromwell-road, S.W.
Paterson, John, 1, Walbrook, E.C.
Ross, Sir Charles H. A. F. L., Bart., D.L., Balnagown Castle, Parkhill, Ross-shire, Scotland.
Walter, Mrs., Bear Wood, Wokingham.
Wiener, Augustus Frederick, 4, Bedford-place, Russell-square, W.C.
Woolf, Joseph, jun., 32, Victoria-street, S.W.

The paper read was—

INDUSTRIAL REDISTRIBUTION: THE CRUX OF THE OVERCROWDING QUESTION.

By William Leonard Madgen.

One of the first things to strike the visitor to London from abroad is the apparently hopeless entanglement and obstruction of traffic. Whether he travels by rail or road, or whether he merely tries to elbow his way through the busy streets on foot, he finds himself losing time in every direction. In parts of the metropolis the railway time-table may be regarded as little better than a work of fiction with an unhappy ending, and few of us expect a cab or omnibus to proceed otherwise than by short impulses between intervals of uncertain repose. And beneath the pavement, if we could take an X-ray photograph, we should see a dense mass of conduits and cables which are constantly requiring additions and alterations, thus bringing about the periodical breaking up of streets that are at all times too narrow for the torrent of traffic. So it happens that the water supply, the drainage, the telephone, the telegraph, the gas, the electric supply, and such modern necessities actually become in some sense a nuisance and cause of obstruction.

Periodically, schemes have been devised for relieving congestion, but they have generally tended to make things rather worse than they were before. Local traffic facilities within a congested trade and residential area increase of not only the suburban, but of the central population; and whatever other useful purpose they may serve, it is certainly no check to the crowding tendency in London and other great towns.

London has, in fact, long since outgrown its streets and its railways, and it has apparently unlimited power of overtaking the capacity of new channels of transit. Similarly, it has outgrown its water supply, and the water companies have been abused because nature did not apparently contemplate the settling of six millions of people on the banks of the Thames. The authorities, as we know, do not desire the growth of population to be arrested for want of water, and proposals have been made to bring a supply from Wales in quantities based on the expectation that London will have to harbour not only six, but ten or twelve millions before very long, all of whom are to reach the City, the West End, and the industrial districts by cheap electric tramways, travelling in layers, underground, on the surface and possibly overhead.

Sir J. Wolfe Barry has estimated the loss of time at four points—Cheapside, Strand, Piccadilly, and the junction of Tottenham Court-road with Oxford-street—as equivalent to a monetary loss of £2,154,000 a year, but so far as I am aware no statistical expert has set himself the task of calculating the value of the daily loss of time, energy, and temper occasioned by the inability of London as a whole to assimilate its present population. The item must be a heavy one in that account of national waste which has been a favourite theme of Lord Rosebery's. As the *Times* expresses it, the problem of relieving congestion "is always before the mind of every thinking man who sees the enormous waste of our social and individual energy that is involved in the aggregation of human beings without adequate freedom of movement."

The most casual observer knows by this time that there is an overcrowding problem in London. He knows, therefore, that a very large proportion of the population are living under conditions which impair their physical, moral, and intellectual value to the community, and a little reflection will show him that here again is waste continually going on. It is not my intention, however, to pile up the "horrors" of overcrowding, but to attempt to discuss the subject in its practical aspects. All who have the slightest interest in the continuance of our national prosperity must realise that one of the primary and vital conditions is the maintenance of the physical vigour of the people. During the latter half of the 19th century the decadence of the town workers was counterbalanced by the influx from the rural districts; but such a migration cannot go on for ever, and at the beginning of the 20th century we are seen to be exhausting our reserves in this respect, so that for the maintenance of our position we are dependent for the most part upon the generation now growing up under the conditions prevailing in our great cities. Here are the future workers of nearly every grade who will have to defend the Empire from foreign aggression and to compete with keen and vigorous races in the markets of the world. Numerous empirical remedies are proposed to lure the people "back to the land," most of them making free with the National Treasury for the purpose of loans, bounties, allotments, and the like; but none of them seems to command any degree of confidence. While the international struggle is apparently growing fiercer every decade, our main defensive force must inevitably become weaker unless some measures are taken to conserve the nation's stamina, which is being undermined by the enervating conditions of life in the great towns. That, briefly stated, is the economic aspect of the overcrowding question, the most serious problem confronting the present generation.

It is a curious fact that hitherto this question of overcrowding in London has generally been approached from one side. Both the governing authorities, such as the L C.C., the Vestries and Borough Councils, and philanthropic associations appear to start with the assumption that room must be found not only for the millions already struggling for comfort, but also for any additional number which may gravitate towards the metropolis. They would seem to regard the question, *why* London is overcrowded, as not forming part of the issue. It is sufficient for them that London *is* overcrowded, and that large rebuilding and transport schemes are required to provide for the rush of population. And what is the nature of these schemes in the mass? Purely and simply to make London more attractive for the working classes, more alluring to the rural and provincial labourer, a city paved with gold to the young villager, a paradise for the Polish Jew—in short, to increase the magnetic power of the greatest metropolis in the world. How can this possibly be a permanent remedy for overcrowding? In the past it may reasonably be imagined that many thousands who have turned their eyes towards London have realised that there was a heavy price to pay for the privilege of occupying a very small share of the breathing-space available in the capital. If it is the aim of the L.C.C. and other authorities to remove these deterrents, and promote the pleasures of life in London, there can obviously be no sort of finality to their efforts.

At any rate, if we confine ourselves to our subject of the congestion of great cities, we can scarcely persuade ourselves that municipal exertions in the direction of housing schemes, public nurseries, sanatoriums, and other plans for improving the conditions of life in crowded centres are of any permanent value. They reduce the discomforts of overcrowding, but they do not reduce overcrowding itself, and they do not avert the final judgment of natural laws. The more County Council blocks or cottages are erected, the more internal traffic facilities and other attractions are provided, the more will the demand for accommodation tend to increase. If London gains throughout the world the reputation of being a place in which the worker can live in a suburban villa for three or four shillings a week and travel in municipal tramcars at cost price, it is not unlikely, to say the least, that many hundreds of thousands of disaffected human beings will look longingly in the direction of the London County Council's dominions, and the question of pauper immigration will reach its ultimate stage.

Between the ideals of the advanced members of the County Council and the practical accomplishments of that body there is, however, a not inconsiderable difference, and even the most opportunist have discovered the immense complexity of the task. So far the work of the Council in this department has been to carry out improvements, in conjunction with smaller local authorities, which are a gain to the many but undoubtedly the cause of hardships to the few. The cleansing of insanitary areas is, of course, of far more importance than the provision of dwellings for those unfortunate people who have been turned out, since the existence of such nurseries of epidemics is a constant source of danger to the whole of London, and the obvious duty of the authorities to destroy every one of these plague spots, which are a menace to millions, cannot be hindered by the plea that they serve as a refuge for a few thousands.

Unfortunately, in several cases the Council's schemes have tended to increase overcrowding. Mr. Robert Williams appealed to the members "not to go on cramming more and more people per acre upon the town housing sites which came into their hands;" and Mr. Frank Smith, in criticising the construction of the cottages or brick boxes with slate lids on the Totterdown Estate, asks, "How can the work of a home be carried on in a municipal hole with a floor space 7 ft. 6 in. by 8 ft.?" The boxes, however, are more eligible from a hygienic point of view than the blocks in which the Council packs 700 people to the acre. "Whatever blocks may do, they certainly do not lessen overcrowding," writes Mr. Haw. "In fact, they intensify overcrowding on their own particular area, and they increase overcrowding in the rooms of the small houses on the adjoining areas. . . It nearly always happens that the people displaced from small properties never return to the new block dwellings; they overcrowd the already overcrowed quarters lying near. In the new buildings, where you had 100 to the acre, you now get 1,000. . . . To go on building block dwellings, therefore, would only make matters worse. . . . They no more solve the housing question than they lessen overcrowding."

The huge tenement block is no longer to be regarded as a great sanitary improvement. We now see that we have not only to deal with drainage troubles and defective water supply, but must allow more cubic air space, and that the only satisfactory plan of rehousing involves *the thinning out of the population.*

When these facts became incontrovertible the County Council Housing Committee found themselves brought to a dead stop. They could not make room for the people in the county, and the only apparent course open was to buy land and build cottages outside its boundary. The necessary powers had been provided by Sect. 3 of the Housing of the Working Classes Act of 1900, and the Council proceeded to draw up schemes for providing suburban homes for working men. Will this experiment effect any relief? Before answering that question let us turn to the statement of the problem as laid down in the report of the Royal Commission of 1885:—

> "In examining the causes of overcrowding in the centre of the metropolis, it was shown that the majority of the poor labouring population were under compulsion to live within reach of their work, and that those parts of the town and the suburbs in which there was no pressure were out of the question as places of residence for this class, because they were not within a walk of their employment. Again, the earnings of the class in question were shown to be at a rate that left no margin for the extra cost of travelling expenses.
>
> "If therefore, the railways are to be utilised for the benefit of the poorer wage-earning classes, two conditions must be satisfied—first, the fares must not exceed the difference between the rent of their homes in the overcrowded districts, which ought to be relieved, and the lower rents in the suburbs; secondly, the companies must provide carriages which will bring the people to and from their work at convenient hours."

That is what is now insisted upon by every writer on the subject, and is, indeed, self-evident; the worker must be near his work; not necessarily within so many miles, but within so many minutes. Even granting, then, that the County Council has by going further afield conquered the space problem, it has clearly at the same time created a time problem. It has, in other words, thrown the responsibility on the railways and tramways. But, as everyone knows, the railway termini are already almost choked; the central streets almost impassable. How, then, is the resident at Tottenham or Norbury to be whisked through the air to his work in the industrial quarters? Already the headway between trains on many of the suburban lines is as close as it can be consistent with safety, and the elasticity of the system is taxed to the utmost. Even if the railways are compelled to displace trains carrying passengers who pay the statutory fare in order to make room for more cheap trains for workmen, it is well known that the additional accommodation will only induce more traffic. The efficacy of widening for additional lines is very questionable, even if we ignore the immense cost it would involve, as the difficulty is a cumulative one; and, moreover, every slice of land taken by a railway company in the London area displaces a fresh crowd of people.

And if there is no room on the railways, neither is there any on the streets. From about 5.30 to 7.30 the omnibuses and tramcars are only to be taken by storm or by the method adopted by weaker passengers, who walk a little way homewards, and board a car on its way up in order to secure a seat for the return journey. By road transport it will take more than an hour for a working man to travel from the centre of London to the new cottage at Norbury which the County Council is building for him. He will lose 12 hours a week, and it will cost him a shilling or two, which is an important item in family accounts based on a revenue of 30s. a week. The champions of these illusory schemes now see the difficulty themselves, and they are urging that railway facilities should precede and not follow the demand. The warmest advocates of this colonial policy are apparently alive to the uselessness of erecting the cottages without first making sure of the means of carrying workmen to and from these cottages. Mr. David S. Waterlow, chairman of the County Council Housing Committee, writes as follows in the *Fortnightly Review* (January, 1901):—

> "If new areas are to be chosen whereon to build additional residences, these areas must bear some relationship to the centres of work—must be in touch with them, either by reason of satisfactory means of locomotion or by reason of proximity for walking to and fro. New areas cannot be arbitrarily chosen. The working classes will not, and cannot, settle just where Mr. Jones happens to see vacant spaces on the map of London. They can settle only where economically it is profitable for them to settle, and this happens to be in the districts where past legislation and administration has allowed acres of God's earth to be occupied by row after row of

the most unhealthy and ugly dwellings which the perverse ingenuity of the small capitalist has been able to devise. The economically suitable sites for working classes are the plague spots of London, and the problem is how to turn these sites into healthy occupied sites. Such sites, too, are in great demand for all commercial purposes, such as factories, warehouses, &c., and for these purposes they command far higher rents than anyone can afford to pay for the erection of working-class dwellings, the result being that old dwellings cannot be replaced by new ones on economical lines."

This is from the chairman of the Housing Committee, the spokesman of the Council's colonial policy, who, according to the *Municipal Journal*, laid this Tottenham project before the Council "with an air of natural pride that well became the sponsor of the largest housing scheme ever proposed for London." How Mr. Waterlow could support that natural air of pride, when he has shown us that Tottenham was not economically suitable, can only be understood with the assistance of a sense of humour. Mr. Steadman, an East End Councillor, admitted that the scheme would not help the working man in his constituency in the least, but he voted for it "mainly because it was a step in the direction of the public ownership of land." From this point of view we may regard it not so much a scheme for housing the working man as one for colouring the dreams of doctrinaire Socialists.

Without going further into the rehousing question, we may consider that we have cleared the ground for the purpose of this essay, and that certain conclusions may be drawn:—

1. That London is dangerously overcrowded. Mr. George Haw estimates that 900,000 people are living under conditions which defy the Public Health Act.

2. That the industrial efficiency of the working population is largely reduced by disease, exhaustion, and other causes, directly due to overcrowding.

3. That there is no remedy yet discovered for dealing with these evils, short of a drastic scheme for removing hundreds of thousands from the metropolis and systematically discouraging immigration.

4. That the so-called colonial policy of the London County Council does not meet the difficulty, and that it is in effect, as looked at from different points of view, either an effort to convince the electorate of the activity of the Council, or merely an experimental illustration of the political principle of communal ownership of land,

5. That even if the most idealistic schemes of this kind were temporarily successful, London would become so much more attractive that the population would increase faster than ever.

6. That the housing of the poor is not a local question which can be permanently settled by municipal authorities.

Having, I hope, somewhat shaken the theory that a municipal governing body is bound to find house-room, not only for all the native population, but also for any number that may choose to pour into the town from all quarters, I see only two courses remaining: the one, to leave the problem to be settled by natural laws, while vigorously enforcing sanitary regulations; and the other, to aim at a comprehensive scheme of industrial redistribution.

This is not a problem peculiar to London, and I have only dealt with London as the great example. For the same reason I shall continue to give special attention to London, although there are many districts in the provinces—my native district, the Tyneside, for example—where the conditions are similar in character, though less in extent.

The attempted removal of a class to a spot some miles and many minutes distant from their daily occupation is not a sound system of colonisation at all. As a writer in the *Daily Chronicle* remarks: "Unless the County Council is prepared to provide something more than another huge dormitory, its scheme to house 42,000 people, all of the same class as the present 100,000 people who live in Tottenham, will only tend to add to the dead level of joyless monotony that hangs like a cloud over so many working-class districts to-day. When great masses of the people are brought together in this way it is not enough merely to house them. . . . Merely to dump down 42,000 people by the side 100,000 other people without regard to their social needs, would have the effect of forcing them into a humdrum existence worse than that of the East Ender, who at least has his People's Palace, technical institutes, museums, clubs, social settlements, public libraries, and now a permanent art gallery." In the view of this writer, who is by no means unfriendly towards the Council, Tottenham will be rather less attractive than Mile End as a residential district for the working classes. It seems a fair question to ask whether, instead of demanding ever-increasing passenger trains to carry workmen from the suburbs to the bottle-neck termini in the centre of London, we should not take measures to arrange that they may work near their homes ten or twenty or thirty miles out, and that the product of their labour may be carried by goods train on the main lines and by tram waggons through the streets at night, when there is no other traffic.

My conviction is that the best practical method of dealing with this great national question of congestion of population is to aim at the creation of complete and self-contained colonies, in which factories and cottages, places of recreation and so forth, may all grow up together.

A glance at the trade classification section of the Post Office Directory will reveal the fact that, quite apart from the army of butchers and bakers, clothiers and builders who must find room in every town, and whose numbers are of course proportionate to the total population, there are very many thousands of men and women employed in London factories whose trade is not local but national, and frequently foreign. It is, therefore, worth while to inquire what necessity exists for their present situation. Looking through the Directory, I find under the single letter B long lists of makers of such things as boilers, boots, bottles, brushes, buttons, bedsteads, billiard tables, and many others, such as bookbinders and brassfounders, who are carrying on work which could be done more comfortably and efficiently elsewhere. Many of these places of work were established long ago, when London was less thickly populated, and there they have remained, year after year gradually becoming closed in by a thicker and thicker wall of congestion. Some few have already taken the hint and shaken off the smoke of London. As the author of "No Room to Live" observes, "One of the healthiest signs in modern London is the drift of large employers to outside townships, taking their men with them, and in some cases building them cottages. Specially is this a feature in the printing trades. Several large firms have transferred their works twenty and thirty miles away. They find as a consequence that instead of losing their London work they have increased it, because their men, amid better surroundings, both at home and on duty, are able to become cleverer craftsmen and keep more regular time." In other words they are in a stronger commercial position. Instead of aiming at the London County Councillor's ideal of leaving the factory at Bermondsey, with the proprietor at Hampstead, the manager at Sydenham, the clerks at Forest Gate or Wimbledon, and the workmen at Tottenham or Norbury, all struggling twice a day to find room in railway carriages or tramcars, all wasting time and energy and money, you have the business and the home within short walking distance, and the staff better housed, better fed, and far more able and contended.

Three questions arise from the observation of this commercial phenomenon:—(1) Are there any reasons why this migration of industry should not become more general? (2) Are any obstacles thrown in the way by local authorities? (3) Is there any method by which the Legislature can encourage the movement? As regards the first, we can see that many of our towns were founded centuries ago to suit the conditions of the time, and that our ancestors were not concerned to provide for the requirements of the 20th century. It was sufficient for them that they had a road and a river, and some means of defending themselves from attack. In course of time towns have grown in importance because of their favourable position on a waterway or on a main road, or (in more recent times) on a railway. They have become classified as centres—agricultural, mineral, manufacturing, distributing, and transporting. And if we add the class which consists of recreation and health resorts, we have comprised the whole country. What, then, is London? It appears to be all these things, except that it is not particularly rich in minerals and has no very great reputation just now as a health resort. Its size and importance are mainly due to two causes:—(1) Its position on the Thames estuary, which makes it a great seaport; and (2) its being the seat of the Legislature and Judiciary, the residence of the Court and aristocracy, and consequently a permanent magnet drawing towards it the ambitious and the pleasure-seekers from all parts of the country. For an art and science centre it possesses attractions, but the circumstances would have been happier if it had never been allowed to grow into one of the largest manufacturing towns in the world in the face of manifest disadvantages; if, for example, we had never been left to puzzle why Peek, Frean and Co. should make biscuits at Bermondsey, while Reading is good enough for Huntley and Palmer; or why Cadbury's chocolate can find comfortable quarters at Bourneville, while Crosse and Blackwell's jams and pickles settle down in Soho; or why the London and South-Western Railway works should be at Nine Elms and the Great Eastern should employ 5,000 men at Stratford, while such places as Crewe and Swindon suit the purpose of other great railways.

Mr. Justice Grantham has drawn attention to a few more leading cases—*Times*, February 28, 1901. He says: "Take Doulton's and similar works as an example. They bring their clay from Dorsetshire and Cornwall, their coal from the Midlands, and their salt from Cheshire to London; they then use an enormous quantity of valuable and costly water, and having made their pipes and sanitary ware, they send them back to the source of origin of their component parts as well as to all parts of the world." And he instances besides the great furniture factories and engineering works, which are out of place in London. Their removal, it must be remembered, would not only mean the migration of the workmen directly employed. They are attended by a train of relatives, and by butchers, bakers, grocers, tailors, milkmen, tobacconists, postmen, &c., who again are surrounded by their families and their trade connections. So that the trekking of 10,000 artisans employed by a few factories would at once cause a considerable gap in such parts as Stepney or Bermondsey.

It is fairly certain that no manufacturer about to commence business at the present day, would fix upon London as a suitable position. He would choose rather a district in which land was cheap, and in which he could obtain cheap power for his machinery and transport for his goods. He should not in future be limited to the colliery districts, or to the main lines of railway. Light railways serving as feeders to the main lines, and the supply of electrical energy over large areas from main power stations, could provide for both these requirements, giving the manufacturer ample assurance that his works could be run cheaply, and that the raw material and manufactured products could be efficiently handled. By such means, electrical science is capable of opening up thousands of square miles in England for manufacturing purposes, the native population of which has been languishing under the chronic complaint of agricultural depression.

Primarily I am now dealing with the distribution of the manufacturing population; but the subject is one which closely affects the agricultural development of the country. Whether a nation like ours, which is dependent upon foreign supplies for the necessaries of life, is in a favourable condition to enter upon a great war need not be discussed here, but our position would be decidedly stronger if any means could be found of stimulating home food production. The relationship between this very desirable consummation and the overcrowding question is very interesting, and as it has been ably dealt with by Captain Petavel in his little book entitled "A Coming Revolution," I venture to summarise his arguments and conclusions.

The cultivating value of land depends not merely upon the nature of its soil, but also upon the accessibility of a market for its produce; and it is a serious complaint of farmers in this country that they are unable to dispose of fruits, vegetables, dairy produce, &c., because of the difficulty and costliness of distribution. We spend many millions a year on the importation of these commodities, not because they cannot be produced here, but because it is cheaper to ship them from abroad to our great towns than to collect and send them from the agricultural districts of the interior.

Now it is easy to see that if, instead of the country being divided into a few densely populated manufacturing centres and wide tracts of almost wasted agricultural land, we aimed at the multiplication of smaller manufacturing towns, each constituting a regular market, each surrounded by its own belt of cultivated soil, from which the delivery of produce would be relatively inexpensive, we should be on the way towards the cure of agricultural depression. To take an example, such an immense belt of farmland would be required to sustain London, and the obstructions to distribution are so nearly prohibitive, that a large proportion of provender comes up the Thames from abroad, not because our own land cannot produce it, but because it cannot be profitably collected and delivered. Consequently a large part of Essex, which would lie within that belt, has seriously depreciated. Remove part of London further into Essex, so as to form a self-contained town within its own agricultural belt, and cultivation would immediately be stimulated. The decentralisation of manufacturing industries automatically increases the value of agricultural land. Incidentally, the factory hands and other artisans have more space, more opportunity, and more inclination for cultivating the soil on the allotment system. In short, such decentralisation is an important step towards the conservation of the wealth of the nation, and enables a greater proportion of the inhabitants to be supported by the natural fertility of their own soil, instead of being dependent on foreign supplies.

The problem of rural overcrowding is of a nature entirely different from urban overcrowding. In the latter case people can and do pay high rents for miserable accommodation, but in the country the only reason for the short supply of cottages is to be found in the impoverished condition of the tenantry. The development of numerous small towns in closer touch with rural districts would, by improving the demand for agricultural labour, render the people able to pay fair rents and inhabit roomier and cleaner cottages. Look at the question of overcrowding from every point of view, and its dependency upon the distribution of manufacturing industry is easily demonstrated.

If we have decided that there are no natural advantages in congested centres for manufacturing purposes, but that, on the contrary, their unwieldy magnitude, dense population, and physically inefficient labour constitute serious disabilities, we may proceed to deal with the second question, viz.: Are any obstacles thrown in the way by local authorities? This draws us at once into the whirl of parochial politics. Are the numerous and varied corporations, councils and boards on the side of progress or on the side of stagnation? So far, indeed, from being the most suitable implements to tackle the congestion problem, they are themselves the most ponderous obstacle in the path of its solution. Next to the slum "sweaters" who grind the faces of the poor, many councillors are the most determined opponents of any plan which threatens to reduce the local population; and, unfortunately, where there is power given to deal summarily with the landlords of insanitary property, it is practically impossible to overcome the inertia of a supine local authority. Fairly conclusive on this point is the report of the Royal Commission, which contains the following humiliating paragraph:—

> "The state of the houses of the working-classes in Clerkenwell, the overcrowding and other evils which act and react on one another, must be attributed in a large measure to the default of the responsible local authority. Clerkenwell does not stand alone: from various parts of London the same complaints are heard of insanitary property being owned by members of the vestries or district boards, and of sanitary inspection being ineffectually done because many of the persons whose duty it is to see that a better state of things should exist are those who are interested in keeping things as they are."

But it is not merely the property jobbers who, as members of the local governing body, consider it their interest to keep things as they are. Besides owners of property, insanitary or otherwise, such a council nearly always contains a majority of shopkeepers, estate agents, and the like, who stand to benefit by a rising population, and to lose by decreasing numbers. In the neighbourhoods where human beings are herded together 1,000 to the acre, and in which there is a death-rate running up to 30 per 1,000, the general dealer and the undertaker cannot take quite such a broad and impartial view of the overcrowding question, as the stray visitor from the countryside, who finds it difficult to support for a few minutes conditions which are normal to these unfortunate creatures.

It would be most unfair not to admit at once that there are men of intellect, derived from every class, who have given their services to the cause of local government, who are both independent and humane, and who are actuated by genuine public spirit; and that there are towns which are lucky enough to possess a working majority of this class. But such men find it very uphill work to struggle against the limitations of their colleagues. What is the attitude of the average elected person towards anything in the nature of industrial redistribution? What are likely to be his feelings when he sees a gradual migration of workpeople, and occasionally a large factory on the trek? Naturally he regards such changes as a direct menace to the prosperity of the town, and, in a secondary degree, of course, the prosperity of himself. A reduction of the local rateable value is a calamity calling for special intercession, and the departure of a large factory is a disaster which he would like to prevent by every available means. How can a great national question like industrial congestion be left subject to the veto of such instruments as these? It is unfair to the nation and it is unfair to them.

Whatever deprecatory adjectives may be showered on these people, there is really a great deal to be said in their excuse. The Imperial Government is more to blame than they are in raising this conflict of the parish against the nation, that so far has given most victories to the parish, and is one of the most harassing conditions with which industrial England is weighted in her competition with foreign countries.

Mr. George Bernard Shaw, who would certainly claim to be on the side of progress, showed in a recent speech at Birmingham that there is yet another disability attaching to the parochial politician. He confessed freely that the St. Pancras Council, of which he is a member, knows perfectly well that there is abominable overcrowding in flagrant defiance of the Public Health Acts, but the local authority cannot, or at least does not, take remedial steps for the reason that the councillors are representatives, and that a large proportion of their constituents are interested in letting things remain as they are. The overcrowded voters know well enough that any serious housing scheme would altogether upset their domestic arrangements. Such is the unwholesome confusion of things that they would appear to be in league with the slum landlord and property jobber, in opposition to the destruction of the unclean "rookeries" which are the only shelter they can obtain. "But," says Mr. Shaw, "if the Local Government Board would only wake up . . . !" From those who are constantly striving for additional powers of one kind or another this is a serious confession of impotence to carry out those already entrusted to them.

When we come to consider the third question: Whether the Legislature can and should deal with the overcrowding question on broad lines of national expediency, it is necessary, first of all, to examine the nature and extent of the areas controlled by local authorities, and we are at once confronted with the fact that our system of local government rests upon what may be a very convenient boundary system in relation to the social order and common duties of the inhabitants, but when viewed in the light of modern political science and industrial progress, is in many cases an extremely inconvenient and uneconomic delimitation of districts. These boundaries were fixed at various periods with reference to the jurisdiction of ecclesiastical authorities, school boards, sewage commissioners, and general local administrators. Sometimes the areas coincide; very often they do not. They have no natural reference whatever to such matters as industrial development or the housing of the working classes; and they were certainly not designed for the purpose of plotting out the most suitable areas for the economic distribution of water or gas or electricity, or for the provision of mechanical means of transport. Our forebears who settled upon those boundaries had, of course, nothing of the sort in their minds. They decided that a certain area was conveniently compact for the administration of its own; and in this way districts have grown up. And to this day, notwithstanding all the developments of science, so great is the inertia of independent thought that we still find our Legislature complacently ministering to the view that, because a certain area has a local government system, therefore it is fitted for an electrical supply system. Instead of ignoring the boundaries so far as they obstruct the progress of industry, Parliament actually attempts to pack the latest developments of electrical science within limits which were intended simply for purposes of ecclesiastical, or magisterial, or public health jurisdiction. We should be careful how we attempt to put geographical boundaries to the application of science; but if a survey were made nowadays to determine the boundaries of districts in relation to their industrial development, the Commissioners would not decide that because a town has a mayor and council and a board of guardians, therefore it should also have a light railway system of its own.

When personal enterprise seeks to further the modern system of electric power distribution, or light railway construction, it widens its plans to include groups of towns, so that the population of the whole district gets the benefit of a comprehensive scheme, contrived in such a manner as to effect the utmost economy and utility. Yet such schemes, manifestly of national importance, which bear an intimate relation to this overcrowding question that we are discussing, almost invariably meet with bitter and strenuous opposition from the aldermen and councillors of the several towns, who demand that the large area which has attracted the attention of the advanced electrical engineer shall be parcelled out into a number of small local monopolies worked on antiquated lines. Each town must have its own toy generating station, and its own little tram-line shuttling from one street corner to another; and an enterprise which has projected a network of light railways connecting, perhaps, half a score of towns, and a comprehensive scheme of cheap power supply is obstructed on the ground that the boundaries, which were fixed simply with reference to the maintenance of order and the control of public health, are equally well fitted for traction and power schemes.

An equally dangerous conflict between national and parochial interests has arisen before, and the manner in which it was dealt with affords useful guidance in forming a decision on the similar question of to-day. I am referring, as may have been anticipated, to the invention of steam locomotion, to the prompt application of which the prosperity of this country during the 19th century was very largely attributable.

In the great period of railway construction which was to bring so much gain to the country there were towns which fought desperately against the invasion of the steam engine. But, as Sir William Harcourt has pointed out, fortunately the country was at that time under the influence of a great statesman, Sir Robert Peel, and in the general interests of the nation many of these petty obstructionists were put in their proper place. Railway makers were allowed to build with more regard to the map of England than the map of Little Pedlington, and for many years we were far ahead of any other country in the completeness of our railway system. Now we have entered upon a new industrial era, it is a melancholy truth that not alone America and Germany, but even such countries as Italy and Switzerland, are showing us a lead. The daily paper and the man in the street thoughtlessly reproach the British electrical engineer, ignorant of the fact that there is a political as well as a technical side to the question of electrical progress, and that however strenuously our engineers may persevere, they are helpless in face of the small tradesman who, as alderman or councillor, believes that the interests of his district would be imperilled by giving electrical enterprise fair-play. Just as the steam locomotive had at first to be driven by politicians through certain parts of the country, so it must be demanded of Parliament that it shall break down the barriers of ignorance and prejudice which prevent the nation from attaining its full commercial development by the prompt adoption of modern scientific discoveries. What is required from Parliament to-day is the removal of those legislative difficulties which hamper the supply of cheap power for industrial purposes, and restrict the construction of comprehensive systems of light railways as auxiliaries to the main lines.

Such facilities will work great changes in the grouping of our population. This can, I think, be easily understood if we bear in mind that there can only be two main causes for the congestion of the great towns. Crowds move from the rural to the manufacturing districts either in search of work, of pleasure, or both. Several thoughtful writers have shown how the dulness of village life as revealed to young men who, by the spread of education, know that there is a gayer world outside, is largely responsible for the rush to the towns. As a writer in the *Daily Chronicle* says, life is intolerably dreary for the labourer in country districts. "The day's work over, there exists for the labourer, for purposes of social intercourse, only the village pub. . . . Education has worked its silent evolution in country districts as it has elsewhere. It has endowed the cottager not only with new mental powers but with a widened horizon. He is captivated by the far-away glamour of city life, where at least promotion and higher wages reward the energetic; and so he goes away and swells the ranks of civic constabulary, or helps to man the overcrowded shops of the larger towns." Here, again, we are reminded that if, in spite of the continuous advertisement of the horrors of its slums, the Lights of London prove almost irresistible to the countryman, what will be the effect if its attractions are increased by the continuing philanthropy of its ratepayers? Says Sir Henry Campbell-Bannerman: "The tendency to aggregate in the great towns exists in every civillised country, but wherever it exists, when carried to an extreme it is a great misfortune and calamity to the nation at large. It is a thing which we ought to do everything in our power to check." What, then, is the London County Council or any other municipal body doing to check it? They are all, on the contrary, devising all sorts of schemes for packing more and more people in or near their boundaries, and for attracting crowds from elsewhere. The national interest is being directly opposed by the local interest. The "great misfortune and calamity," of which the Liberal leader speaks is being hastened and intensified by the very people who are entrusted with the mission of reform.

What, then, is to be done? Obviously, if the calamity arises from the brightness and bustling activity of town life, as contrasted with the dulness and stagnation of country life, the remedy is not to heighten the contrast, but to try and equalise matters. Plant a few factories, some playing-fields, and a sensible place of entertainment in a rural neighbourhood, and the attractions of London are diminished. Instead of the villagers coming to London in search of work and amusement, work and amusement are brougt to them. The growth of large towns should not be encouraged; the growth of small towns should be fostered. Inter-urban light railways will allow the inhabitants to enlarge their social horizon by cheap and frequent visits to adjoining towns. Indirectly the agricultural industry, the decline of which is so greatly deplored, will be stimulated, not merely for the reasons I have already given, but also because the inhabitants of the villages having such improved means of communication with the towns would be more content to settle down on the land. They would not be in a state of melancholy exile, as they are now.

In taking stock, then, of our business premises, we look at the map of England, and we recognise at once that whatever may be the case in the big towns, the country as a whole is certainly not overcrowded. We have room for more labour. We have, again, assets which are, either wholly or partially, lying unproductive. We have large tracts of uncultivated land. We have hundreds of miles of roadways and waterways of which little use is made for commercial purposes. While in the United States there are 20,000 miles of electric light railways, we in this country have not yet constructed our first 1,000 miles. We have, further, some 3,000 miles of canals and 2,000 miles of navigable rivers, much of which, if properly utilised, would have an enormous traffic capacity. Lastly, we have a very large number of well situated small towns, offering what an auctioneer would call eligible building sites. There are, in fact, many things valuable to industry which are at present lying waste. The problem is how to bring out their latent profit-earning powers for the benefit of the nation. This is, indeed, the bright side of the over-crowding question. The population of the United Kingdom is certainly not too large, and there is productive work enough for all. At present we have on the one hand a great waste and leakage of labour owing to low vitality amongst the masses in large towns, and on the other hand waste and neglect of industrial sites, traffic facilities, and so forth throughout the country. If we can remove that labour to healthier centres, thus increasing its efficiency, and if at the same time we can develop the natural and artificial riches of now neglected districts, we shall obviously bring about economic changes tending towards the greater prosperity and comfort of the community.

The task of adapting such small towns is comparatively easy, if only the Legislature will remove the restrictions to which reference has been made. The necessaray conditions are, in my opinion :—

1. The provision of cheap power for driving machinery.

2. Increased traffic facilities by means of light railways.

3. The improvement of the canal system by the use of mechanical haulage, &c.

4. The intelligent design of industrial building estates.

To deal with No. 4 first, it is clear that we ought to exercise sufficient foresight to prevent any overcrowding problem in the future in those districts we propose to develop. There must be no more narrow courts and sunless alleys, and there must be a due proportion of planted open space to every set of dwellings.

The remaining three conditions may be grouped together. For cheap power and for cheap traction by road or canal we must call in the electrical engineer. But at present the law of England in respect of these matters is in such a curious state, that instead of immediately setting to work wherever there is a suitable field for his industry and science, the electrical engineeer has to spend months, and perhaps years, in journeying between the town-hall and the House of Commons. Posterity will surely be amazed that, at the dawn of the 20th century, the Legislature still allowed local authorities with arbitrary boundaries and with interests so curious and involved, the power of veto over comprehensive electrical projects.

It is only just to acknowledge that the rural councils for the most part rapidly recognise the value of schemes for the improvement of their districts; but they are in many cases deprived of increased population and adjacent markets by the narrow obstinacy of urban councils, and Parliament has for many years given greater consideration to the blank veto of an urban council than to the needs of large agricultural areas in its neighbourhood. The history of these efforts to realise the dormant assets of the country and render it more habitable and more prosperous is one miserable series of struggles against local ignorance and Parliamentary indifference.

Meanwhile we have constant references by such men as Lord Salisbury, Lord Rosebery, Mr. Balfour, and Sir Henry Campbell-Bannerman to the "great housing problem"—exceedingly sympathetic, but also exceedingly vague. And we have the edifying spectacle of local authorities continually crying out for greater powers of a perfectly futile character while the Government retorts by rebuking them for not exercising what powers they already possess. If both parties to this dispute would give their single-minded encouragement to the migration of industry, they would find that this "great housing problem," of which they speak with such voluble ineptitude, would speedily solve itself. Grant to personal enterprise and electrical science greater freedom in the development of our small towns, and manufacturers will readily avail themselves of the advantages in the shape of cheaper land and more efficient labour which such towns will afford.

In the interesting project of Mr. Ebenezer Howard, now widely known as the "Garden City" scheme, the plan contemplates a town site of 1,000 acres surrounded by an agricultural belt of 5,000 acres, which it is expected would do a prosperous business in supplying food to the central area, and in that case would no doubt be actually preferred for residential purposes by many of the settlers. But I must reluctantly confess that while the Garden City Association has undoubtedly done much to direct public opinion, I do not regard the model town of its aspirations as a very practical objective. In the first place, it is unnecessary; since, as I have already remarked, there are admirably situated small towns such as Hertford, for example, suitable for a similar purpose which have the great advantage of already possessing the nucleus of a commercial and social organisation in the shape of railway facilities, river or canal frontage, distributing agencies of all kinds, schools, hospitals, water supply, drainage, and so on. To start and build an entirely new town on model lines must be such a serious undertaking that only the plea of absolute necessity could render it justifiable. Prudent manufacturers will certainly prefer to wait and watch the experiment rather than lead the way, for, attractive as the plan may appear, no one can forecast the actual success of the settlement, and it is quite likely, as has been the case in other model colonies, that the pioneers would meet with unforeseen difficulties. The only successful ventures of this kind have been those which have been founded in furtherance of personal enterprise, such as Messrs. Lever Brothers' Port Sunlight and Messrs. Cadburys' Bournville, and, perhaps the most interesting of all, the model town of Echota, which has been built up in association with the Niagara electric power scheme and the industries which it has attracted. These great undertakings found it desirable to found such settlements; but it does not follow that a miscellaneous group of manufacturers would flock to Garden City. On the contrary, there are provisions in the scheme which seem likely to warn them away. Take, for example, the item in the Association's Tract No. 1 under the heading of "Justice." It reads thus: "Garden City must be an advance towards juster conditions, inclining the balance in favour of the weaker and more helpless members of the colony." In the light of cold common sense it does not seem probable that manufacturers will migrate to the Garden City with any such motive in their minds, or that a strong and well-organised firm will trustfully settle down in Garden City when they see a notice on the gate that the aim of its promoters is to "incline the balance in favour of the weaker and more helpless members of the colony."

As time went on it does not seem probable that the situation would improve from the manufacturers' point of view. The scheme contemplates communal ownership of the land, in which the working class will be predominant partner: in the words of the Association, cities are to be founded "in which the inhabitants shall become in a corporate capacity the owners of the sites." Our experience must teach us that the inevitable result would be that Garden City would become a close corporation of an obstructive character. It is improbable that the democratic government of such a city would give much consideration to the personal interests of the manufacturers, a minority of individuals. On the contrary, the legislation would tend in one direction, to place more and more power and profit in the hands of one class, and to restrict the immigration and competition of other workmen who might be attracted towards the town. I am not now criticising such a policy so far as it affects the workmen; my point is merely that as human nature is to day, and as it has been this many hundred years, such a prospect is scarcely likely to allure the average manufacturer, when there are so many small towns which will suit his purpose at least equally well in respect of natural and commercial advantages, and are not likely to become the scene of advanced socialistic experiments. We had better recognise that there is only one reason which will induce manufacturers to trek from one town to another. As Mr. Waterlow said of the working man, the manufacturer will settle where it is economically profitable for him to settle. There is no reason whatever why half a dozen manufacturers, for instance, should not combine to form a garden city, if it is a sound business venture, or why, if it succeeded, they should not take a fair profit as the reward of an enterprise which would be a most valuable object-lesson to the whole country. I have good reason to believe that an endeavour of this nature will be made.

The mischievous tendency to decry personal enterprise, and to magnify in every spirited adventure merely the "somebody on the make," ought to be discountenanced in the very interests of philanthropy, since it is an undoubted fact that mankind owes as much to the business instincts and courage of individuals taking personal risks as to all the machinery of State driven by the revenues either of nations or of municipalities.

In the great struggle for commercial supremacy there is no lack in this country of both brains and money. Personal enterprise can save England, if it is granted fairplay by the Legislature and protected from municipal blackmail. It does not make for national progress that anyone wishing to introduce a new industry into a town should have to pay heavy tolls at its gates if it is admitted at all; that an electric traction undertaking, for example, serving miles of country, should only be given entrance subject to numerous onerous conditions tending to inflate the capital and ultimately form a tax on the traffic.

From different points of critical view it may be said to be either the strength or the weakness of my case that it practically consists of a succession of truisms. That the nation, like the individual, can work better, develop its wealth more freely, and enjoy greater prosperity when its people are granted more elbow-room and healthier surroundings does not admit of argument. I have, therefore, limited myself to pointing out the conditions which cramp and confine the industry of the country. I have left the individual hardships of the overcrowded poor for others to describe; and, on the other hand, I have sought to further no political ideals. While I am to a certain extent in sympathy with those who have given earnest study to this problem, I cannot refrain from taxing many of them with the fault of allowing themselves to be swayed by remote objectives. Such a problem as overcrowding, for example, is too often examined through coloured spectacles. The Parliamentarian thinks of party; the Socialist thinks of land nationalisation as a condition precedent to the relief of congestion, and so forth. But is it necessary to wait for the realisation of these aspirations? I am not asking anyone to give up his belief in land nationalisation and State ownership; but I would urge that these things are at least some distance off; while the evils of overcrowding are very near to us. The proposals I have made must be recognised as having the great advantage of facility. I merely indicate that there is already a tendency for industry to scatter over a larger area and settle in smaller centres, and I ask that this movement shall be encouraged by the breaking down of local obstruction; that the industrial population shall be allowed to follow this favourable current, and find natural harbourage. I have claimed that practical science and personal enterprise are ready and able to open up new fields for industrial colonisation, and before any more doubtful experiments are made in the direction of municipal housing schemes and internal traffic services, it is in accordance with the best traditions of English politics that free development should have the first chance.

There are labour leaders who hold, as we know, that the working man does not get a sufficient share of the proceeds of industry; and they look to State or Municipal ownership for higher wages. There are, again, people belonging to other classes who, for more obscure reasons, sometimes no more than the love of local power and patronage, give their support to the municipalisation of various kinds of businesses, and both these classes frequently block the path of enterprise simply because it is personal enterprise, without any regard to the public utility of the work it proposes to undertake, or to its special fitness for that work. It is difficult to obtain from them any definite pronouncement as to the principles upon which their policy is based, or the lengths to which they are prepared to go in the direction of municipal monopolies. They are influenced by the curious impression that personal enterprise is their enemy, although they are nearly all beholden to personal enterprise for their own means of livelihood. It is much more satisfactory to deal with the frank and outspoken Socialist, who endeavours to reduce his opinions to some sort of a system. His ultimate ideal is a State monopoly in everything—all the sources of wealth and the means of production and distribution. I recognise that he is opposed to personal enterprise on certain definite political principles; but I would point out to him that such individual effort as I have been referring to is obviously not calculated to retard the realisation of his ideals. On the contrary, it has been claimed by Socialists that the formation of large commercial organisations is actually an important step in the direction of public ownership, on the theory that commended itself to Nero, namely, that it is more convenient to chop off one head than a thousand.

I cannot see, therefore, why even the most advanced politicians, who, like all of us, must have the prosperity of the country continuously in view, should regard the migration of industry with anything but favourable opinions. And unless they are able to disprove my claim that the municipal bodies are in most cases either unable or unwilling to afford any substantial relief to the overcrowded, or any material assistance to the development of manufactures in line with modern conditions, I appeal for their goodwill in endeavouring to obtain fair-play for those who are able and willing at least to make an attempt. Otherwise it is probable that their supporters will presently stampede. If something is not done greatly to alleviate the present conditions it is inevitable that the prosperity of the country will be seriously affected. It is in times of adversity that the electors of this country may be tempted to give heed to the remedies of opportunist politicians, so that it is not at all unlikely that local and Parliamentary obstruction of industrial redistribution will, if persisted in, culminate in the establishment of a protective tariff, which, rightly or wrongly, would seriously affect the destiny of parties.

My aim in this paper has been to show that the overcrowding and ill-housing of the industrial classes is not merely a deplorable evil in its effect upon the stamina and vitality of the race, but that it is a serious hindrance to the economic utilisation of the wealth of the country. We are, in short, not making the most of the valuable assets with which nature has endowed the British Isles. We are cramping and confining our capital and labour, instead of opening up the whole country to manufacturing and agricultural progress. Under prevailing conditions, the larger towns, by reason of the establishment of uneconomic municipal monopolies, and the impossibility of effecting any permanent improvement in the housing of the working classes, are becoming less and less suitable as sites for industries which have to compete with more favoured rivals in Europe and the United States; and I earnestly plead that it is one of the primary duties of Parliament to afford facilities for the free expansion of our manufacturing interests, instead of allowing them to be overshadowed by the retail tradesmen of the neighbourhood who form such a large proportion of the town councils.

The Legislature can find no more pressing work than the task of relieving the congestion of the great cities by encouraging personal enterprise to add to the convenience, accessibility and attractiveness of the smaller towns and rural districts. If the migration of industry once sets in on an important scale, if the example of those few manufacturers who have within recent years settled in such districts as Bedford, Chelmsford, Lincoln, Loughborough, Newark and Rugby, be accelerated by cheap power supply and improved traffic facilities, no question need arise of compelling the factories to move away. It will scarcely be possible for a London factory to compete with its country rivals, but in relation to foreign competition the potential commercial power of the nation will be considerably strengthened. Much is said about the wonderful success of our colonising policy in various quarters of the globe, and about the exuberant vitality of Greater Britain; but it seldom seems to have occurred to our politicians that there is a great field for colonisation in England itself. The impression is far too prevalent that this country has reached the limit of her industrial success, and the despondent sensational articles in the press might be accepted as fair descriptions of the decline of a people who have had a glorious innings, and must now stand aside and watch America and Germany contending for the world's industrial championship. To anyone who has a real knowledge of the many natural advantages which we possess, this tendency to despair and cease from struggling is merely a symptom of temporary aberration. If our people are granted more elbow-room and more breathing-space, if fairplay is granted to the genius of the inventor and to the enterprise of the individual, and if an intelligent and consistent effort is made by the Government to realise the conception of Great Britain as an industrial whole, we shall be quite able to hold our own in competition with any other nation on earth.

In conclusion, I beg to express my thanks to Mr. Henry Brown, F.C.A., and to Mr. T. C. Elder for their great assistance in the preparation of this paper.

DISCUSSION.

Mr. EBENEZER HOWARD thought that if engineering and architectural skill were brought to bear upon a large estate of about 6,000 acres, they would produce conditions superior to any which had hitherto been known either in this country or the whole world. It seemed to him that the reader of the paper had erred in thinking the small towns would be the birthplace of a great migratory movement. He thought the great migratory movement foreseen by Mr. Madgen would be due to the fact that a great experiment would be tried with regard to one large area, the results of which would be so surprising that the movement would go forward with great rapidity. Although he was not an engineer, he was confident that he could convince a committee of engineers that even if a tract of land was taken which, at the present time, was regarded as quite unsuitable for the commencement of a town, conditions would be created which would make the scheme a success. The Americans were waking up to that idea. He saw in an article in the *St. Louis Bulletin*, in connection with the great exhibition of 1902, the following suggestion, with which he entirely concurred. Beautiful Expositions were built which were designed with the utmost care in order that the buildings should harmonise in their arrangement and colour. All that was done for a purely temporary purpose. Why should not the same thing be done with regard to the planning of towns?

Mr. R. H. SCOTTER thought there were in the present conditions of the country facilities for carrying out such a scheme as the reader of the paper had propounded, and that it was not necessary to wait for any new idea to be carried out in order to realise that ideal. For instance, in Lancashire, Cheshire, and the adjacent counties, there was a magnificent system of railways and canals; and if the Light Railways Act were adopted, and a system of intercommunication could be carried out, many difficulties would be solved. By a carefully devised system of inter-urban railways, it would be possible to carry, quickly and efficiently, to the markets tons of fresh vegetables and fruit which were now either neglected, or sold at a very small figure by the farmers. He contended that the principle of decentralisation from the enormously congested centres to smaller subordinate centres, each served by its own particular industry, and its own system of communication with the other centres, could be carried out immediately, and was being carried out at the present time in many places in England with most beneficial results. In his opinion such measures could be better carried out by private enterprise than by municipal enterprise, for the reason that municipalities had defined areas, and were not able to deal with the very districts to which attention ought to be given—the country which lay between two or more defined areas of municipalities or small towns which needed to be brought into touch with the centre. He did not quite agree with what Mr. Madgen had said against municipalities, as long as they kept within their legitimate limits. There were undoubtedly a good many unprogressive small municipalities in the country to which the attention of the Legislature should be called; but on the other hand, on many municipalities there were men who could take a broad view of the case. But on such an important national question, private enterprise ought to have a free hand. It was his belief that a great deal of the energy which was wasted upon enterprise outside the country might, with very much better results, be directed to the country itself. England was a country rich in minerals and agricultural produce; yet parts of it were undeveloped, many of which could be turned to profitable advantage if better means of intercommunication were established. The Light Railway Act had certainly given them the facilities for developing the country.

Mr. A. MORESBY-WHITE thought the reader of the paper had put his finger upon the real heart of the subject, when he said that the crux of the overcrowding question was bound up with the old areas of towns, which had come down to them from the days of King Alfred. Boards of Guardians and Urban and Rural County Councils were very well in their way, but they were not fit to deal with the question of the housing of the poor. The London County Council could not house the poor in London, or in the County of London. It was perfectly ridiculous, in connection with the question of sewage, that there should be on the banks of the River Thames between 500 and 600 sewage authorities, all with different ideas, sending their undiluted filth into the river, the water of which the inhabitants of London eventually had to drink. The principle suggested by Mr. Madgen was an excellent one, and should be applied to all watersheds, light railways, and methods of communication which presented such narrow sub-divisions. The main objection to local authorities, with regard to the means of communication, was that the roads were knocked up. In his opinion, all arterial roads should be taken out of the control of any particular locality, and placed in the hands of a department of the Government, thus preventing every wretched little municipality opposing useful Bills in Parliament. With regard to the housing of the working-classes, it was absolutely impossible to house any poor person under the present regulations of the Local Government Board, which required a certain cubic space for air and light, and certain rules dealing with the building of sanitary conveniences which it was impossible to comply with. He was entirely in sympathy with Mr. Madgen's scheme for extensive methods of communication; but in connection with the question of freights on railways, at present the light railways were only used for passenger traffic. The enormous prices charged by the railway companies for freight had strangled local and rural trade all over the country; and if the light railways would only enter into competition with the trunk lines and carry goods it would be an excellent thing for many districts. He was sorry to say the reader of the paper was right in his statement that most of the councils were composed of small tradesmen who controlled municipal affairs; but that was due to the fact that the best men could not spare the time to devote to municipal matters. When gentlemen were prepared to sacrifice a little of their valuable time for the interests of their towns such a state of affairs would not exist.

Alderman **Ivey** said that the London County Council at the present time in more than one centre were about to dump down in the area of a neighbouring authority thousands of people for whom they could not provide sufficient accommodation. Tottenham, although its rates were enormously high, was to find accommodation for 40,000 of the surplus population of London. What would be the effect? All those connected with local government life knew that the artisan population did not carry a profit to the local rate. Supposing a cottage was assessed at £10, and the rates were 10s. in the £, £5 in rates would be received per annum. The cottage would probably contain six persons, two adults and four children. Assuming that three of the children attended school, and each child cost £2 15s. to educate, there was at once a deficit for School Board purposes alone, not taking into consideration the Poor and other rates. He did not think it was possible to create as a speculative and commercial venture the town proposed by Mr. Howard, because it would be found that after the ideal city was built, the desirable people did not flock to it with the promptitude which was hoped for. Some of the older towns which had a system of government, must be improved by means of facilities being given in travelling, trade and commerce, and in that way the problem would be more easily solved than by the method suggested by Mr. Howard.

Mr. J. A. **Lycett** thought that a fillip should be given to the great captains of industry who were at the present time conducting large enterprises within the precincts of congested areas. In Birmingham the large manufacturers, in a great measure, were realising that it was to their advantage to get outside the heavily-rated districts, because they obtained better results from the workpeople by shifting their manufactures into suburban areas. He had also seen the benefit at Niagara of attracting people from the congested centres by providing cheap fuel and many other industrial facilities. He had also seen the effect of the spirit of enterprise which prevailed in Canada, particularly in Toronto, where land was provided, upon which manufactories could be erected. He noticed also that, in order to scatter the people, 18 factories had been built along Lake Ontario by Messrs. Lever Brothers, who had had the land given to them for that purpose; the result being that quite a small town was springing up in the vicinity. He had also found that some of the municipalities in Canada were prepared to raise money on their own rateable values in order to encourage industry, to avoid as far as possible crowded centres, and dispense with the evils attendant upon overcrowding. If the paper was scattered broadcast in the country, he could not help thinking that it would induce some of the large manufacturers in towns like London, Birmingham, Bristol, and other big cities to seriously think the matter over with a view of improving the conditions of the working-classes. One of the means by which that happy result could be secured would be by laying down new feeding lines of railway, and by improving and utilising the means of transport on the canals and rivers. He could not help thinking that whilst the Garden City scheme was very beautiful, the most practical form of endeavouring to bring about that state of things was to make use of the advantages which had been provided from time immemorial, and attracting not only manufacturers to the small towns, but the people who, at the present time, were herded together in unfortunate circumstances.

Mr. **Sydney Morse** said it seemed to him that the reader of the paper had put forward a feasible plan, because not only had the poor people to be considered, but the manufacturers also. Owing to the prevalence of such high rents, rates, and taxes in the large cities, it was impossible to carry on trade with a reasonable return for the capital expended. The question of the housing of the working-classes was bound up with a larger question. In order to carry out Mr. Madgen's plan, it would be necessary for the owners of the factories in the smaller districts to meet their customers for the purpose of discussing contracts, and that facility should be given for the delivery of the produce. All such matters pointed to the absolute necessity of private enterprise having a free hand. Private enterprise was one of the rocks upon which the present position of the country had been built, and upon which alone it could stand. He only regretted that the exigencies of maintaining their seats in Parliament prevented many members of the House from insisting that private enterprise should have a free hand throughout the country.

Mr. J. I. **Thornycroft**, F.R.S., thought that smal towns some distance from London would be develope and made more useful if they were better connecte with the metropolis, because it would always b necessary for the principals of the firms to come to tow on business matters. After inquiring into the subjec he had found that one had to go to a place 40 or 5 miles from London before obtaining a good trai service; so that very often a town 30 miles away, i point of time, was farther away than the town at 4 or 50 miles on the same line. It was quite possibl that electricity would come to their aid in cor nection with high speed, because he was given to understand that much greater speed could be safely attained when the train was propelled by an electric motor than by an ordinary locomotive in which the oscillating parts caused vibration and instability of the line when high speeds were attempted. There was no doubt, as Mr. Madgen had said, that the large towns had proved an attraction to the people, the result being a population so dense that vitality was lost. An educated workman's life was shortened and his utility wasted by unhealthy surroundings. There were many manufactures in London which would be better elsewhere. With regard to transport, if only a moderate distance had to be travelled it could be done more cheaply on the road than on a light railway. The ordinary road had great capacities, but it must be well made and wide, so that the traffic could proceed at a greater velocity than was now the case.

Mr. GEORGE BEAVIS asked whether, if the system of decentralisation was carried out, the cost of the carriage of goods would not be greatly increased, and whether it would not greatly interfere with educational advantages.

The CHAIRMAN said he could not help contrasting the state of affairs in the streets of London in the days of his boyhood with that at the present time. In driving past Hyde-park-corner of a morning he saw probably seven omnibuses on one side of the road, and eight on the other, as close together as they possibly could be; but he could recollect the time when if one looked down Cornhill only a couple of Hackney coaches would be seen. If the present state of things went on, where their successors would be in a hundred years' time he did not know. The question was an extremely important one. The streets were originally made to accommodate the then existing population, and the authorities now could not afford to widen them on account of the extreme value of the property. It was unreasonable to expect the population of the present day, which was not only greater in number, but in activity, to accommodate itself to thoroughfares made 80 years ago. He could hardly trust himself to speak on the question of municipal trading. He was concerned in getting through both Houses of Parliament the Mond Gas Bill, which sought for powers to supply an area of 135 square miles. In that area there were 27 separate local authorities, averaging an authority in every five square miles. Worked into squares, each area was 2¼ miles in extent, so that at every 2¼ miles the promoters had to take their hats off to the Chairman, or the Mayor, and the inevitable Town Clerk. All but two of the 27 authorities petitioned against the Bill. It was discovered that eight of the authorities had entered into trade as makers and distributers of gas and electricity, and now they thought their undertakings would be ruined, and a hardship thus imposed upon the ratepayers. The answer they received was that they should not have embarked in trade unless they were prepared to meet the ordinary incidents of trade and rivalry. He hoped the scheme would fructify, and be the means of giving cheap power throughont an extended area. The word "blackmail" had been used in the paper. When the telephone was first brought to England, and submitted to the authorities, it was considered a very interesting toy. Private individuals, without Parliamentary powers, thereupon worked the invention, but the Post-office authorities, on finding it was a success, intervened, and said they held a monopoly of telegraphs, telephones coming under that head. It was eventually decided that it was an infringement of the Post-office monopoly, and from that time the Telephone Company had had to pay a royalty to the Post-office of 10 per cent. of its net profits. In the early stages of the electric lighting industry, in 1882, an Act was passed to the effect that electric lighting companies should at the end of 21 years sell their property to the local authority for the then value of the materials, without any compensation for the goodwill of the business or compulsory sale. He was thankful to say that for a long while promoters refused to build works on such terms, with the result that by the Act of 1888 the term was extended to 42 years. But during those six years interval, other nations were hard at work, with the result, that at the present day the manufacture of electrical machinery for all purposes was settled in the United States, Germany, and Switzerland, and not in England, as it ought to be. He was the director of an Electric Lighting Company, which had been recently enlarging its means of production, and he was ashamed to say they had bought the whole of their new electrical plant from Germany and Switzerland, because it could be obtained more cheaply, more quickly, and equally as trustworthy as in England. This was the outcome of the mischievous pandering to municipal electrical lighting trading. In conclusion, he proposed a hearty vote of thanks to Mr. Madgen for his valuable paper.

The vote of thanks having been carried unanimously,

Mr. MADGEN, in reply, said for the most part, the comments had confirmed the arguments educed in the paper. Mr. Howard had drawn a comparison between an exhibition of beautiful and uniform buildings and the equipment of a residential settlement. If Mr. Howard had been an engineer, he would have wondered whether an exhibition provided all the necessities of domestic and daily commercial life. No provision was made in an exhibition for a nursery or a chemist's shop, for a water supply or other requirements of a permanent settlement. Mr. Morse and Mr. Thornycroft had referred to the need of the sales department of the works being in touch with the large centres where the demand occurred. In Manchester, there was a large Exchange, which was attended twice a week by those concerned in the management of cotton mills throughout the district, and there the business was conducted. In consequence of the widening of the South-Western Railway, a large firm moved their London works to Bedford. They had no siding in London, but, at Bedford they had magnificent works close to the station, with a siding right into the works; and it took no longer to get from Bedford to the City than it did from Brighton. Mr. White had alluded to the rather onerous conditions laid down by the Local Government Board in regard to buildings for the accommodation of the working-classes. The Local Government Board were advised by a very able body of men, and on going into the matter it would be probably found they were justified in the rules they had made. If local authorities, however, were content to control buildings instead of building themselves, reasonable conditions could be placed on private enterprise in particular districts. It was quite probable that the redistribution of industry would increase the carriage on goods to some extent; but that was only one item in the cost of production and distribution. The firm with which he was connected found it could get printing, equal to the best American printing, done in Weston-Super-Mare and delivered in London at 20 per cent. less than the London price. He thought the redistribution would tend to improve education. The altruistic spirit was spreading amongst manufacturers, who found it best that their workmen should be well educated, happy and healthy. If he went to Port Sunlight or Bournville, he should be quite prepared to find that private enterprise had provided in a most careful and thoughtful manner for the education of the children of the workmen. If that was so, the effect of industrial redistribution would be to relieve the rates of a good deal of the cost of education, which now pressed so heavily upon them.

EMIGRATION FROM BRITISH INDIA.

The India Office has communicated a statement, together with tables, showing the emigration from British India in recent years, which is published in the *Board of Trade Jonrnal.*

From these statistics it appears that the number of emigrants from India during the five years 1885-86 to 1900-01, and the number of returned emigrants during the same period, was as follows:—

	Number Emigrated.	Number Returned.
Five years ending 1885-86....	73,312	32,546
,, ,, 1890-91....	62,332	39,194
,, ,, 1895-96....	72,977	30,304
,, ,, 1900-01....	95,616	31,186
Total	304,237	133,230

The mortality amongst emigrants is high in some of the colonies to which they go, and of those who survive a substantial proportion elect to continue to work in the colony after their term of indenture expires, and many of these never return to India. In Mauritius, for instance, about 69 per cent. of the population (261,739 out of a population of 379,659) are Indian settlers and their descendants; in Demerara a third of the population of the colony consists of Indians; and in Natal, Trinidad, and elsewhere, the settled Indians are increasing in numbers.

There are five places in India from which emigration may be legally carried on—Calcutta, Bombay, Madras, and the two French settlements of Pondicherry and Karikal. From Bombay emigration ceased many years ago, and general recruiting has never been resumed, labour in the Western Preidency being, on the whole, so well paid that there is but little inducement to emigrate to the coolie-employing colonies. That port and the port of Karáchi, however, have recently been used for the shipment of male labourers destined for work on the Uganda railway, who were recruited under agreements made with or on behalf of H.M. Government. Over 27,000 such labourers, most recruited in the Punjab, have left Karáchi for that purpose in the last three years. From the French settlements there has been no emigration since 1884, except in one year 1888-89. The port of Calcutta is the most convenient for the shipment of emigrants drawn from the impoverished masses of the thickly populated districts of Oudh, Bihár, and the eastern section of the North-Western Provinces, and the main streams of emigration flows from that region down the Hooghly. Of the persons who emigrated from India in 1900-01, 11,510 (being 43 per cent.) were shipped from Calcutta, the greater number of them from the North-Western Provinces, Oudh, Native States, and Bihár. Their destinations were British Guiana, Trinidad, Natal, Mauritius, and Fiji. From Madras 6,966 were shipped during the year, recruited exclusively from the Madras Presidency, mostly from the southern (Tamil) districts. These went to Natal and Mauritius. There is a considerable flow of native labourers from Madras to Ceylon and the Straits, but this traffic is not conducted under the provisions of the Emigration Act.

The destinations of the emigrants in the last five years were as follows:—

To	1896-97.	1897-98.	1898-99.	1899-00.	1900-01.
Mauritius	802	426	—	—	3,229
Natal	4,038	6,036	4,958	1,590	6,312
Demerara.........	2,417	1,194	2,380	4,959	3,932
Trinidad	3,043	1,851	1,268	1,798	2,450
Dutch Guiana...	500	618	616	—	—
Fiji	1,953	567	—	1,490	2,553
Jamaica	—	—	623	670	—
Mombasa	2,819	2,793	9,479	9,931	8,032
Other destinations	—	—	289	—	—
Total	15,572	13,485	19,613	20,438	26,508

The figures in the tables appended to the above statement relate solely to emigration as carried on under laws regulating emigration. They take no account of the numbers who leave India as passengers, not having been recruited by emigration agencies for service in the Colonies, these being separately dealt with. The tables also take no account of persons who leave India on pilgrimage to the holy places in Arabia, of whom small but uncertain numbers settle out of India.

NAVAL AND MILITARY EXHIBITION, CRYSTAL PALACE, 1901.

Admiral Morant, Chairman of the Naval and Military Exhibition, reports that the various Service Distributions have benefited to the extent of £4,577 9s. 6d. by the sale of Season and Concert Tickets in connection with this Exhibition.

The amounts received by the Institutions are as follows :—

	By Sale of Exhibition Season Tickets.			By Donations from Concert Proceeds.		
	£	s.	d.	£	s.	d.
Soldiers' and Sailors' Families' Association	2,760	0	0	380	0	0
Lady Lansdowne's Fund for Officers' Families	468	10	0	100	0	0
Lady Dudley's Fund for Sick Officers and Nurses	261	12	0	180	0	0
Royal School for Daughters of Officers of the Army........	134	18	6	50	0	0
Soldiers' and Sailors' Help Society	40	19	0	100	0	0
The National Memorial, Gordon Boys' Home	11	11	0	50	0	0
The Central British Red Cross Committee................	7	7	0	—		
The Soldiers' Daughters' Home	5	5	0	—		
Royal School for Naval and Marine Officers' Daughters	4	4	0	20	0	0
The Royal Naval Fund	3	3	0	—		
Total	£3,697	9	6	£880	0	0

COMMERCIAL RESOURCES OF TIERRA DEL FUEGO.

The archipelago of Tierra del Fuego is usually represented as a desolate, unproductive country, yet the principal islands possess dense forests, and most of them have numerous streams of water. The territory of Magellanes, which belongs to Chili, is, according to the latest reports, especially destined to become prosperous. Sheep rearing, and the exploitation of building woods and of petroleum wells are among its sources of wealth. Magnetic iron abounds, and coal, although of mediocre quality, is found on the Atlantic coast and on the Straits. Punta Arenus, the capital, owes its rapid development to sheep rearing and gold washing. The sheep of this region appear to be native to it; the wool is longer, more silky and tougher than the Argentine wool, and is not greasy. It is said to find a ready sale in English markets. There is no sickness among the sheep. The chief exports are gold, in dust and nuggets, wool, ostrich feathers, skins of llamas and of seals, live sheep, frozen mutton, and tallow. In the last five years, three concessions on the south coast of the Strait have been made to English societies. On the north coast of the Strait are some very prosperous French concessions. The only Argentine establishment is at the southern extremity of the archipelago. The island of Hoste, which is very mountainous, has a colony established by an English mission; the washing of the auriferous sands here has given good results. Punta Arenas is a free port. Merchants, especially from Argentina, flock there, exchanging their manufactured articles, almost at the European price, for skins, gold, and building wood. The Chilian Government keeps a small squadron of steamers to police the canal, protect the shipwrecked, and prevent gold washing or seal killing by unauthorised persons.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

FEBRUARY 19.—"The Use of Balloons in War." By ERIC H. STUART BRUCE, M.A. GENERAL SIR GEORGE WENTWORTH A. HIGGINSON, K.C.B., will preside.

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E. SIR OWEN ROBERTS, D.C.L., will preside.

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS. LORD RAYLEIGH, D.C.L., LL.D., F.R.S., will preside.

MARCH 12.—"The Utility of Alkaline Phosphatic Manures." By JOHN HUGHES, F.I.C. PROFESSOR HENRY A. ARMSTRONG, L.L.D., F.R.S. will preside.

MARCH 19.—"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S. SIR WILLIAM ABNEY, K.C.B., D.C.L., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

FEBRUARY 27.—"The Industrial Development of India." By NILKANTH B. WAGLÉ, B.A. The EARL of HARDWICKE will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 18.—"The French Canadian Relationship to the Crown." By W. T. R. PRESTON, Chief Inspector Canadian Government Emigration Agencies. LORD STRATHCONA and MOUNT ROYAL, G.C.M.G., LL.D., will preside.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

MARCH 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY. WALTER CRANE, A.R.W.S., will preside.

CANTOR LECTURES.

CYRIL DAVENPORT, F.S.A., "History of Personal Jewellery from Prehistoric Times." Three Lectures.

LECTURE II.—FEBRUARY 17—Ear RINGS, nose-rings, toe-rings, lip-rings, and finger-rings—Ecclesiastical, royal, and military rings—Posy and gimmal rings and ring anecdotes—Mediæval talismanic rings, mourning, puzzle, and watch rings.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Cyril Davenport, "Personal Jewellery from Pre-historic Times." (Lecture II.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. C. F. Harford-Battersby, "The Obstacles to Development in West Africa."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. F. W. Bedford, "Baldassare Peruzzi."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Professor Edward Hull, "The Physical History of the Norwegian Fjords."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Edwin Freshfield, "Archæology in London as a Pastime for a Busy Man."

TUESDAY, FEB. 18..SOCIETY OF ARTS, John-street, Adelphi, W.C. 4½ p.m. (Colonial Section.) Mr. W. T. R. Preston (Canadian Emigration Commissioner), "The French-Canadian Relationship to the Crown."

Royal Institution, Albemarle-street W., 3 p.m. Dr. Allan Macfadyen, "The Cell: its Means of Offence and Defence. Immunity." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. W. M. Mordey and Bernard M. Jenkin, "Electrical Traction on Railways."

Statistical, 9 Adelphi-terrace, W.C., 5 p.m. Mr. Fred. J. Atkinson, "A Statistical Review of the Income and Wealth of British India."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. C. I. Forsyth Major, "*Mustela palæattica* from the Upper Miocene of Pickermi and Samos." 2. Mr. Oldfield Thomas, "Two new Genera of Rodents from Potosi, Bolivia." 3. Mr. G. A. Boulenger, "Some Characters distinguishing the Young of various Species of *Polypterus*."

WEDNESDAY, FEB. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Mr. Eric Stuart Bruce, "The Use of Balloons in War."

Meteorological, 70, Victoria-street, S.W., 7½ p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1901." 2. Mr. W. N. Shaw, "'La Lune mange les Nuages.'—A Note on the Thermal Relations of Floating Clouds."

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. E. M. Nelson, "Polarising with the Microscope."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. J. Brown, "Enzyme Action." 2. Messrs. H. T. Brown and T. A. Glendinning, "The Velocity of Hydrolysis of Starch by Diastase, with some remarks on Enzyme Action." 3. Mr. O. Silberrad, "Polymerization Products from Diazoacetic Ester." 4. Messrs. S. Ruhemann and H. E. Stapleton, "Condensation of Phenols with Esters of Unsaturated Acids" (Part VII.). 5. Mr. H. B. Baker, "The Union of Hydrogen and Oxygen."

THURSDAY, FEB. 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Miss L. Digby, (1) "Some Gasteropoda (*Limnotrochus Chitra*) from Lake Tanganyika with the Description of a new Genus; (2) the Nyassa Vivipara and its Relationship to *Neothauma*." 2. Dr. O. Stapf, "The Fruit of *Melocanna bambusoides*, an Exalbuminous Grass." 3. Dr. J. E. Duerden. "A West Indian Sea Anemone, *Bunodeopsis globulifera*."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. L. R. W. Forrest, "The Second City of the Empire."

Society for the Encouragement of Fine Arts, 6½ Suffolk-street, Pall-mall, S.W., 8 p.m. Sir Wyke Bayliss, "Shakespere in relation to the Evolution of Landscape Art."

Royal Institution, Albemarle-street, W., 3 p.m. Rev. John Watson, "The Scot of the 18th Century." (Lecture III. With his Books.)

Historical, Clifford's-inn, Fleet-street, E.C., 8½ p.m.

Architectural Assoc., 56, Great Marlborough-street, W., 7½ p.m. (Discussion Section.) Mr. F. C. Eden, "The Organ—Its Proper Position and Architectural Treatment."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, FEB. 21...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. Duddell, "Musical and Talking Electric Arcs."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. 1. Discussion on Mr. H. F. L. Orcott's paper, "Modern Machine Methods." 2. Mr. Henry D. Marshall, "Fencing of Steam and Gas-Engines." 3. Mr. Samuel R. Platt, "Fencing or Guarding Machinery used in Textile Factories." 4. Mr. Henry C. Walker, "Protection of Lift-Shafts, and Safety Devices in Connection with Lift Doors and Controlling Gear." 5. Mr. W. H. Johnson, "Guarding Machine Tools."

Geological, Burlington-house, W., 3 p.m. Annual Meeting.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, FEB. 22...Irish Literary (at the HOUSE OF TH SOCIETY OF ARTS), 8 p.m. General Sir Willia Butler, "The Cromwellian Wars in Ireland."

Royal Institution, Albemarle-street, W., 3 p.m. Lor Rayleigh, "Some Electrical Developments." (Lecture II.)

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FRIDAY, FEBRUARY 21, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, February 24, 8 p.m. (Cantor Lecture.) Cyril Davenport, F.S.A., "The History of Personal Jewellery from Prehistoric Times." (Lecture III.)

Wednesday, February 26, 8 p.m. (Ordinary Meeting.) Professor Roberts Beaumont, M.I.Mech.E., "Recent Inventions in Weaving Machinery."

Thursday, February 27, 4.30 p.m. (Indian Section.) Nilkanth B. Wagle, B.A., "The Industrial Development of India."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

Mr. Cyril Davenport delivered the second lecture of his course on "The History of Personal Jewellery from Prehistoric Times," on Monday evening, 17th inst.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday, February 18, 1902; The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., LL.D., in the chair.

The paper read was "The French Canadians and their Relations to the Crown." By W. T. R. Preston, Commissioner of Emigration for the Dominion of Canada.

The paper will be published in a future number of the *Journal.*

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 4, 1902; His Eminence Cardinal Vaughan in the chair.

The paper read was—

THE HISTORY OF THE ROSARY IN ALL COUNTRIES.

By the Rev. Herbert Thurston, S.J.

Although at the present day some justification will seem necessary for inviting the attention of the members of the Society of Arts to such a topic as the History of the Rosary, it would, I think, in the Middle Ages, have been taken as a matter of course, that there was no organisation to which the subject so naturally belonged as that which dealt with the application of the arts to matters utilitarian. As we learn from the elaborate work on the art and craft associations of Paris, compiled by one Stephen Boyleau, as early as the year 1268,* the *Patenôtriers*, the makers of paternosters or rosaries, represented a most thriving industry, which, even at that date, was divided into four different guilds or companies, distinguished seemingly according to the material in which they worked. The first were artists in bone and horn, the second worked in coral and mother-o'-pearl, the third confined themselves to amber and jet, while the fourth were a more miscellaneous association engaged largely in metal work and the manufacture of buttons, buckles, and rings.

In England the rosary makers do not seem to have been quite so specialised; and, yet, in the London municipal records of the same period, we not unfrequently find citizens described as "paternosterers," and there can be no doubt that their trade primarily consisted in the turning, polishing, perforating, and mounting of beads for devotional purposes. We have record, for instance, of an inquest held in 1278, in the reign of Edward I., in the ward corresponding to that now called Farringdon-street Within, at which three of the witnesses were "paternosterers." They were evidently neighbours, and it seems very probable that they all resided in Paternoster-lane, as it was then called, which, you will notice, lay just under the shadow of the great cathedral, and in the devotional centre of London. The craftsmen themselves lived in Paternoster-lane, but I am inclined to think that their wares were largely retailed by the persons called "stationers," so styled from the fact that they were allowed to occupy certain "stations," or "pitches," as a modern itinerant vendor would say, around St. Paul's-cross and the cross in the Chepe. The stationers did not content themselves with selling objects of piety, they dealt in all things that were needed by the "clerks" or ecclesiastics, who also naturally congregated around the great cathedral, and were in want of the pens, parchment, ink, copies, and books, *i.e.*, manucripts, which formed part of the stationer's stock-in-trade. The stationers have clung to their old haunts, and still predominate in the Row, along with the vendors of pious statuary, holy-water stoups, and other such objects. There was also another Paternoster-lane in the 14th century. It lay beside the Thames in the Vintry ward, close to the church thence called the Paternoster Church,* or St. Michael's the Royal. This was the quarter inhabited by the Gascon vintners, who shipped their wines from the town of La Réole, near Bordeaux. It was natural that they should require objects of devotion in forms familiar to them, and we may assume that French paternosterers settled there to supply the need. We find the same industry flourishing in all great religious centres. In Rome, there is still a street near St. Peter's, called the *Via dei Coronari*,—a *corona* is only a variety of paternoster or rosary—and we have abundant references in documents of the 14th century to the "paternostrari,"† who established their booths in the region of the Vatican. Of course, the paternostrari sold many other miscellaneous wares, mostly devotional, besides rosaries, but the very existence of the name in so many different countries shows that the production of these *fila* or *numeralia de Pater Noster*, strings of beads to count the repetitions of the "Our Father" upon, was a matter of commercial importance. Furthermore, as we shall see, the artistic skill spent in the manufacture of some of these articles of piety, and in furthering the spread of the devotion, was often of a very high order. But before we can deal with the artistic aspects of the subject, we have to travel a very long way back to times and places far remote, for it would be a great mistake to suppose that the use of beads for counting prayers was peculiar to the Catholic Church, or was only of comparatively modern date.

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* "Le Livre des Métiers" (Ed. Lespinasse et Bonnardot), Paris, 1879, p. xvi.

In more than one of the French Cathedrals, as for instance, at Rheims, and at Limoges, we may find representations of the Annunciation of our Blessed Lady, in which she is shown devoutly telling her beads as the angel salutes her. To Catholics at the present day who only use beads to help them in counting their *Aves*, that is to say, *Hail Mary's*, the rosary in our Lady's hand seems a grotesque example of the mediæval disregard of historical verisimilitude, but the detail is not so entirely without excuse as might appear at first sight. After all, the use of rosaries was a practice common to many Oriental races long before the coming of our Lord, and although I know no evidence of its occurrence among the Jewish people, there seems to be, at least, a trace of its appearance in Babylonia, with which, of course, since the captivity, the Jews maintained considerable intercourse. Sir Austin Layard, in his "Monuments of Nineveh," has figured a bas-relief which, according to the description appended to the plate, represents "two winged females standing before the sacred tree in an attitude of worship; they raise the extended right hand, and carry a garland or rosary in their left." My friend, Father Strassmaier, who speaks with authority on such matters, tells me that he is not entirely satisfied as to the meaning of the circlet seen in the picture, and that he is not acquainted with any confirmatory evidence which would establish the use of prayer-beads among the Assyrians; but the details of the bas-relief are highly suggestive of an attempt to represent some act of devotion, and the interpretation of the chaplet as a rosary, is at least probable. Without attempting to settle the matter, it may be noted that the carving probably belongs to the eighth or ninth century before Christ.

Passing to the far East, we come across a number of representations of different deities, many of whom, like Brahma, Siva, the Japanese Amida, and the Chinese Kwan Yin, are commonly represented with rosaries in their hands.

It is possible that some of these can claim a more venerable antiquity than 900 B.C., but it is, I understand, by no means easy to determine with any certainty the dates of Brahmanist and Buddhist antiques, and there is also difficulty in distinguishing the necklaces or strings of jewels often looped around the arms, wrists, and shoulders of these statues, and the rosaries proper intended for instruments of devotion. There seems to be no mention of the rosary in the Vedas, and indeed the traces of its first appearance, whether in Brahmanist or Buddhist literature, are said to be vague and unsatisfactory. It was stated by Mr. Taylor, when lecturing here on Oriental rosaries in 1873, that the rosary was obviously in use among the Hindoos long before the introduction of the Buddhist religion; and we may admit that, on the whole, the theory is plausible.

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* "Liber Custumarum." (Roll's series, p. 749.)

† Armellini, "Chiese di Roma," p. 780, *seq.*

The only allusion to the rosary that I have seen cited from the earlier strata of Oriental literature, is that contained in the following passage from the Buddhist *Forty-two Points of Doctrine*, Article 10:

> The man who, in the practice of virtue applies himself to the extirpation of all his vices is like one who is rolling between his fingers the beads of the chaplet. If he continues taking hold of them one by one, he arrives speedily at the end. By extirpating his bad inclinations one by one, a man arrives thus at perfection.*

Leaving then the question of origins and of priority aside as insoluble with the means at our command, we may turn to gather a few details regarding the use of the rosary by Orientals in modern times, and first of all among the Hindoos. Sir Monier Williams, whose acquaintance with the religious aspects of Indian life was most intimate, speaks as follows.

In regard to rosaries, the rosary (*japa-mala*) used by Saivas (the votaries of Siva) is a simple string of 32 rough berries, or that number doubled, of the Rudraksha-tree (*Elæocarpus Ganitrus*), while that of the Vaishnavas (the followers of Vishnu) is made of the wood of the sacred Tulasi or Tulsi shrub, and generally consists of 108 beads. Such rosaries may be worn as necklaces, though their chief use is to be employed as an aid in the repetition of the names and epithets of the deity, or in the recitation of prayers. Occasional varieties in the material and form of these rosaries may be noticed, for example, Saiva ascetics sometimes carry rosaries formed of the teeth of dead bodies (*danta-mala*), or sling serpents round their neck for necklaces, On the other hand, Vaishnava rosaries are occasionally, but rarely, made of lotus-seeds (*Kamalaksha*).†

I am not sure whether all Saiva rosaries consist of 32 or 64 beads, but they undoubtably are made of Rudraksha-berries, also used by certain sects of the Buddhists. These are supposed, according to a Saiva legend, to recall the tears of Siva which he let fall in a rage, and which became concreted into seeds. Their roughness—the surface is almost like a peach-stone—and their five lobes, corresponding to the god's five faces, may possibly have something to do with this selection. The tulsi-beads used by many of the Vaishnava sects, especially those who pay special reverence to Krishna, play an important part in the rite of initiation to which the children are subjected at the age of six or seven. A rosary of 108 little segments is passed round their necks by the priest or the Maharaja, and they are also taught one or other of the sacred formularies used in reciting it.

The operation of counting is considered by the Hindu ascetic to promote abstraction, a spiritual gift which is greatly prized. But the impression produced on the spectator or auditor by the *nama kirtana* does not always seem to be very etherial, and Dr. Moor in his "Hindu Pantheon" asks a little scornfully how devotion can be aided by hearing the names of Krishna repeated thus: "Huri Krishna, Krishna, Krishna, Krishna, Huri, Huri, Huri, Ram; Huri, Ram, Ram; Huri, Huri."

Some curious extravagances also occur in this matter among the Hindus, and we hear, for instance,* of a rosary suspended from a rafter and consisting of fifteen beads, each as big as a child's head, which as one bead after another was passed through the hands in endless succession must have entailed immense physical fatigue.

That the Buddhists also use rosaries is a fact which many persons, no doubt, will have recently learnt for the first time in reading Mr. Kipling's delightful story of "Kim." Whether the rosary of a Buddhist Lama can be used at a pinch as a measuring-chain I am unable to say. The commonest sort are made of wood or pebbles, berries or bone, and it is said that the poor are content to use a string of only thirty or forty beads, but the more costly varieties are also in favour, and are made of turquoise, coral, amber, silver, or even of pearls and gems. "If a rosary made of the bones of some holy Lama can be procured it is, of course, prized above all others."† In China and Japan the beads are often arranged in two rings. There is considerable variety as regards the formula repeated. To judge from the specimens given by Sir Monier Williams, some of the forms are reverent and devotional enough. But whatever form be used, it always concludes with the traditional *Om mani padme hum* (*Om*, the jewel in the lotus, *hail !*).

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* Dr. Zerffi, in *Journal of the Society of Arts*, 1873, p. 469.

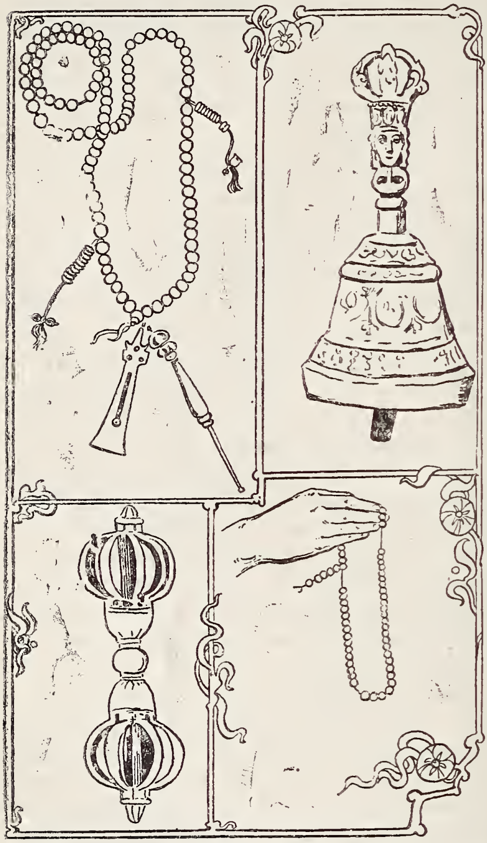
† Sir Monier Williams, "Thought and Life in India," p. 67.

* "The Athenæum," Feb. 9th, 1878, p. 189.

† Monier Williams, "Buddhism," p. 383.

But no modern writer has so fully studied the religious aspects of Buddhism, from within and in its own chosen stronghold, as Mr. L. A. Waddell, who eventually purchased a Lamaist temple, and was received by the Lamas in virtue of an ancient prophecy as a reflex of the Western Buddha Amitabha. Of the many varieties of rosaries in use among the Lamas he gives a very full account. The common and normal type consists of a string of 108 uniform beads, but with two curious appendages, each of ten smaller beads or metal discs, sliding on little cords attached to the main string. These last are called the counters ; at the end of one is found a tiny *dorje*, or miniature thunderbolt, at the end of the other counter is a tiny bell ;* the extremity also of the rosary itself often has miscellaneous objects attached to it, such as keys, tweezers, &c. These, let me note, present a curious analogy with the signet rings and brooches attached to Christian rosaries in the Middle Ages. The discs or beads on the counters are simply used to keep a record of the number of times the rosary is said. One counter marks units, the other tens, and the apparatus thus provided is sufficient to register a hundred repetitions of the whole bead-string, *i.e.* 108 × 10 × 10 mystic formulas in all.

FIG. 1.



BUDDHIST ROSARY WITH BELL AND "DORJE."
MOHAMMEDAN ROSARY.

The rosary may be made of precious materials, and when not in use it is wound round the right wrist like a bracelet, or hung round the neck, with the knotted end uppermost. The King of Maabar (Malabar), whom Marco Polo* visited about A.D. 1290, had a necklace, he tells us, of 104 (?) large pearls and rubies to count his prayers upon. There can be little doubt that Marco should have written 108, which is common both to the Vaishnava and Buddhist rosaries, and often appears as a mystic number.

On the still more complicated forms of rosary (*jiu-dzu*) used by the Buddhists in Japan, as in Burmah, and elsewhere, it would be superfluous to speak ; but it is noteworthy that in Japan the commonest type of rosary seems now-a-days to consist of 112 beads, though other varieties exist, some of them possessing elaborate provisions for registering a high number of repetitions.† Strange to say, from the account of Japan furnished by St. Francis Xavier's native convert, Paul of the Holy Faith, dated 1549, we learn that "the whole nation pray on beads as we do ; those who can read use little books, and those who pray on beads say on each bead a prayer twice as long as the *Pater noster*. These strings of beads or rosaries have one hundred and eight beads. They say that their learned men teach that each man has one hundred and eight sorts of sin, and

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"The Buddhism of Tibet," p. 205.

* It is curious to learn from Marco : "And thus did all the kings, his ancestors before him, and they bequeathed the string of pearls to him that he should do the like. The prayer that they say daily consists of these words : *Pacauta, Pacauta, Pacauta* [*i.e., Bhagava* or *Bhagavata* = Lord]. And this they repeat 104 times."

† Of the Burmese, Mr. Waddell says that "they seem to use the rosary merely for repeating the names of the Buddha Trinity, viz., Phrá or Buddha, Tara or Dhama, and Sángha, and the number of beads in their rosary is a multiple of 3 × 3 as with the Lamas (108 = 9 × 12). He adds that several Burmese possess a rosary of 72 black subcylindrical beads called Bodhi." (See "Journal of the Asiatic Society of Bengal," 1892, pp. 25 and 33.) On Japanese rosaries, see Mr. L. M. James' paper in "Transactions of Asiatic Society of Japan," vol. ix , p. 173.

that he must say a prayer against each of these. The prayer is in a tongue not understood by the people as Latin with us."[*]

But what is of more immediate interest to our present subject is the rosary in use among the Mohammedans called the *subha*, or sometimes *tasbih*, a string of 99, or more strictly, 100 beads, upon which the followers of the Prophets either count salutations, or recite the ninety-nine names or attributes of Allah.

Sir Edwin Arnold, who in his "Light of Asia" has made himself the apologist, if one ought not indeed to say the apostle, of Buddhism, has chosen to pay homage also to the creed of the Prophet in his "Pearls of the Faith, or Islam's Rosary, being the ninety-nine beautiful names of Allah." The ninety-nine beads of the *subha* are divided into three equal portions, sometimes, as in the more ordinary specimens that have been shown me, by a stone or bead of different shape, sometimes, and especially in the more costly varieties, by tassels called *shamsa*, which, made of gold thread and silk of divers colours, have often a very brilliant effect. A hundredth bead of larger size called the Imam, or a tassel in its place, is often added, seemingly to complete the hundred, when the rosary is used for counting *takbir*, *tahlil*, *or tasbih*.

The question, however, which principally interests us in the Mohammedan rosary is the date and manner of its origin. Although little has been written upon the subject, there is a short paper by Professor Goldziher which, in virtue of the author's exceptional acquaintance with Arabic literature, inspires the fullest confidence. It is admitted, he tells us, that reliable evidence of the use of the rosary among Mohammedans has not hitherto been produced earlier than the 3rd century of the Hegira, *i.e.*, the close of the 9th century after Christ, but its use at that time was fully established,[†] and Dr. Goldziher is tempted to believe the story of the famous rebuke addressed by the Caliph Al-Hadi (c. A.D. 786) to his mother, Chezuran: "It is not a woman's business to meddle in matters of state, get thee back to thy prayers and thy *subha*."[‡] As late, however, as the beginning of the 10th century after Christ the use of the rosary seems o have been still looked down upon among Mohammedans as *Bidha*, a novelty hardly worthy of a man of rank and education; for Abu-l-Kasim al-Gunejd (*c.* 913) was reproached for using it, but replied, as any Christian savant might answer in our own day, "I cannot give up any practice that helps me to draw nearer to God." Even as late as A.D. 1350, the use, or at least the exaggerated use of the rosary was made a subject of reproach as something out of harmony with the primitive simplicity of the Moslem creed.[*]

But what is specially interesting to us is a series of passages of somewhat uncertain but unquestionably early date, which seems to throw light upon the actual epoch and manner of the first introduction of the new practice. One of these stories, taken from that body of literature known as "Hadith," and the particular collection called "Sunan"—they are assigned to the 10th century after Christ—will serve sufficiently to illustrate the nature of Dr. Goldziher's quotations:—

"Certain devout Mohammedans, as he tells us, being met together in conversation, one of them, Abu Musa, remarks to his neighbour, 'Formerly O Abd al-Rahmân, I used to see things in the mosques which I could not approve, hut now I see nothing but what is edifying.' 'Of what are you speaking?' inquires the other. 'I have seen,' answers Abu Musa, 'people forming circles while awaiting for the moment of the Salat. Each group had a leader to direct them, and they held in their hands a number of little stones. The president said, 'Repeat a hundred *Takbir* (God is great) and they recited a hundred times the formula of the *Takbir*. Then he told them 'repeat a hundred *Tahlil* (the ejaculation, 'there is no deity but God'), and they recited a hundred times the formula of the *Tahlil*. Finally, he said to them again, 'Say a hundred times the *Tasbih*' ('O, holy God!') and all who formed part of the group carried out what he suggested.' But on hearing this account, Abd al-Rahmân by no means approves of it. At his instance the whole party adjourn to the mosque, and on encountering one of these groups Abd al-Rahmân asked them what they were doing. 'We have a number of little pebbles here,' they replied, 'which we use to count the *Takbir*, the *Tahlil*, and the *Tasbih*, which we keep reciting.' Thereupon, instead of praising them Abd al-Rahmân delivers a very severe rebuke, in which he bids them count their sins and leave their good deeds to keep count of themselves, and reproaches them with trying to know more wisdom than the Prophet, their teacher. 'But, by Allah, O Abd al-Rahmân,' they protest, 'we meant nothing but good.' 'There are many people," he answers them, 'who mean only good, but who never come at it. They are the same of whom the Prophet says that many read the Koran without its ever getting any further than their gullet.' "*

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[*] Coleridge, "Life of St. Francis Xavier II," p. 214. Mr. ames also speaks of the 108 sins or lusts of the flesh.

[†] Kremer, "Culturgeschichte des Orients," quotes Masudy, ii., 119.

[‡] Goldziher in "Revue de l'Histoire des Religions," 1890, ol. xix., p. 295.

[*] See Goldziher, op. cit., p. 297.

From this and several more passages of kindred purport, referring to the use of pebbles in counting prayers, Professor Goldziher is tempted to infer that the custom here spoken of was a sort of primitive *subha*, and was the point of departure for the subsequent development of the Mohammedan rosary. The suggestion seems in every way probable, and the facts must certainly be deemed to throw the gravest doubt upon the assumption almost universally made,† that the Mohammedan bead-chaplet was borrowed full-grown from the Buddhists. It is an assumption for which no evidence is quoted, and beyond the mere fact that beads are threaded on a string, there is no point of resemblance between the two systems.

Of the other principal religions of the world, I do not know any outside the Catholic Church, in which the bead-chaplet is prominent. The word *tschotki*, I believe, in Russian, means a rosary, but the use of such apparatus does not seem to be familiar to the people. Writers have also referred to the *quippos* of the ancient Peruvians; a method of writing by tying knots on cords, as if this also constituted a sort of rosary. But, so far as I can discover, the *quippos* were employed only for calculations, and for recording events, though one form in which pebbles were used, as well as knots, seems, as Father Acosta explains,‡ to have served as a kind of *memoria technica*.

Rosaries, however, are in use among the Copts. They consist most commonly of 41 or 53 beads, and accounts agree in stating that they are employed to number 41 repetitions of the *Kyrie eleison* ("Lord have mercy on us")§ the reiteration of which is also a conspicuous feature in the Coptic liturgy. Whether other prayers are added to these *Kyrie eleisons* does not seem quite clear.

And now, coming at last to the Rosary as used in the Catholic Church, I must begin by expressing my disagreement with the view adopted by Mr. E. B. Tylor and many others, that the devotional exercise was simply imitated from the Mohammedans and introduced into Western Europe through the Crusades. That the suggestion could not possibly have come to Western Europe through the Crusaders, who had, no doubt, many opportunities of watching their Moslem foes piously using their *subha*, would be too much to say. But it is certainly most important to note that the first undoubted mention of the use of beads for counting prayers in the West, to wit, in the instance of the Lady Godiva of Coventry, the wife of Earl Leofric, is anterior by several years to the preaching of the Crusades. The lady bequeathed to the monastery founded by her "a circlet of gems which she had threaded on a string, in order that by fingering them one one by one as she successively recited her prayers she might not fall short of the exact number."* Lady Godiva died before 1070, and this clear and specific statement rests upon what is practically speaking contemporary authority.

But besides this definite evidence of fact, it seems to me that the duty of repeating the same prayer a large number of times, often amounting to more than 100, must inevitably have led spontaneously to the adoption of some contrivance for keeping an accurate record. Not to speak of certain early monks of the desert, it is recorded of St. Godric, an English saint, who died in 1172, that he used pebbles to count his prayers, though we have not the same clear evidence in his case that he strung them on a string, as we have for Lady Godiva. In all the early religious orders, which, like the Carthusians and Cistercians, admitted lay-brothers, the duty of reciting the psalms and lessons of the Divine Office in choir, was replaced for the illiterate by that of saying the Lord's Prayer a definite number of times. The number 150, which is that of the Psalms, was regarded in some sense as specially consecrated by tradition. Just as the Psalms were divided into fifties—so much so, that the recitation of two fifties, or three fifties, in Latin, or Irish, or Anglo-Saxon, was a common form of penance;†—so it was natural that fifty "Our Fathers," or twice, or thrice fifty, should be enjoined as a penance or exacted as a suffrage for the dead, from those who could not read. The constitutions of the Knights of St. John, founded in the 12th century, required as we learn from a bull of Pope Lucius III. in 1185, that the knights who were not clerks should say 150 "Our Fathers" each day. Their *paternoster*, which, in this case, was literally employed for the saying the Lord's Prayer only, remained always a part of their equipment. It may be seen in the hands of their Grand Master on the title-page of Caoursin's "History of Rhodes," and it is lavishly used as an ornament upon the tombs of the Knights in St. John's, Valetta.

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* "Revue de l'Histoire des Religions," xxi., pp. 298—299.

† See for instance, Kremer, "Culturgeschichte," p. 40; Tylor, "Primitive Culture," ii. p. 372.

‡ "Hist. Nat. de las Indias," bk. vi., ch. 9.

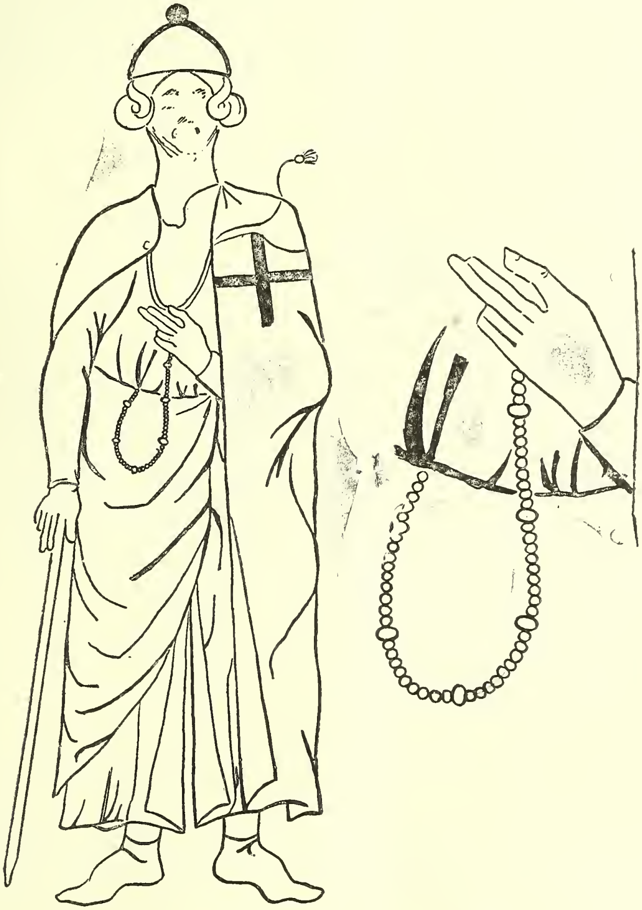
§ A. J, Butler, "The Ancient Coptic Churches of Egypt," vol. ii., p. 238.

* William of Malmesbury, "Gesta Pontificum," book iv., ch. 2.

† See Plummer's note in his Edition of Bede, vol. ii., pp. 137-138.

This duty of reciting the "Our Father" a considerable number of times, and nothing else, in place of the daily office, was practically universal for all monks and religious who had not sufficient education to learn the Latin psalms. Even in the case of the Dominican and Franciscan friars, who were founded at the beginning of the 13th century, we hear nothing in their primitive rule about the *Ave Maria*, or "Hail Mary." The Dominican lay-brothers repeated the "Our Father" alone, as their daily prayer of obligation, until the year 1266. It is easy to understand, then, how the strings of beads used for counting came to be called "paternosters." The name still survives in English in the vocabulary of fishermen to denote a number of hooks set at regular intervals along a line, and it seems also to be known in architecture and heraldry. In the sense of prayer-beads it existed in every European language during the Middle Ages; neither does the primitive signification connecting it with the Lord's Prayer seem to have been entirely lost sight of. I hope to show you a lantern slide of a curious woodcut in the "Speygel der Dogede," a book printed at Lübeck, in 1485, in which Our Lord is represented teaching his disciples the "Our Father," and holding in His hands a pair

Fig. 2.



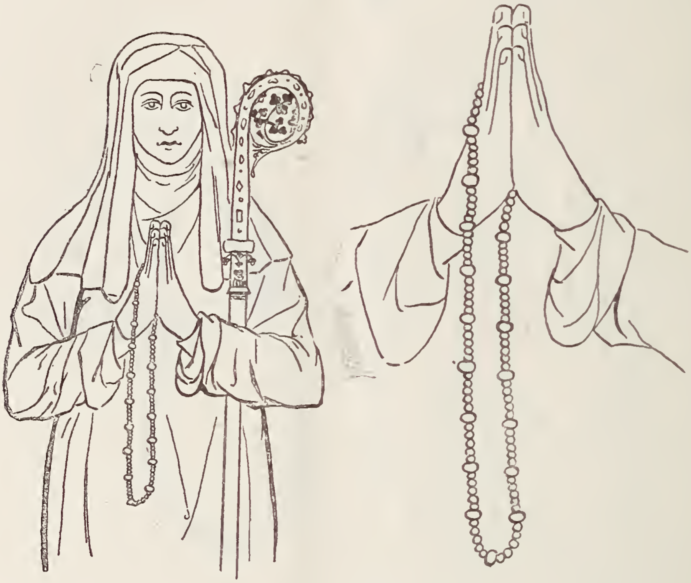
Frere Gerars, Knight Templar, Founder of Villers-le-Temple, A.D. 1273.

of rosary beads.* These paternosters were no doubt of very various length, consisting sometimes of 10, sometimes of 50, sometimes of 150 beads, but for the longer varieties, it must obviously have been found a convenience to divide the beads by markers, as is the case in the Oriental rosaries, notably those used by the Mohammedans. This might be done either by introducing a new bead or knot, or token of some kind, at the end of each ten, or by making each tenth bead larger.

One of the earliest representations of a rosary, which I am able to cite, is taken from the incised tombstone of a knight-templar, dated 1273. There can be little doubt that the paternoster he carries, was used to count the "Our Fathers," which he was required to say by rule. We find it accurately divided into nines, each tenth bead being a big bead.† Other early paternosters are divided by big beads inserted after every five,—again, as I believe, for convenience of counting, and the fact that these larger beads were called in French *seigneaulx* (markers), seems to indicate the purpose for which they were introduced.

And now we pass from the paternoster, properly so-called and used only for saying the Lord's Prayer, to the Rosary of our Lady, the only rosary, practically speaking, now used by Catholics, and the one which, by a widely received tradition, is connected with the Founder of the Dominican Order. Of the controversy regarding the origin of this devotion, this would not be the place to speak. I am only attempting here to treat the archæological and artistic side of the subject; but it will be well perhaps to explain, that in this form of prayer, which has also from a very early period been called our Lady's Psalter, the Hail Mary is repeated 150 times—the number of the psalms—though for convenience sake, this number is divided into three sets of fifty. This is the essence of the devotion, and it is thus, so to speak, an imitation for the benefit of the illiterate of the practice of saying the psalter of David by heart or from a book. Each psalm was represented by an *Ave*, and as the monks, who sing office in choir, are encouraged to believe that it is not necessary to follow the exact sequence of thought of the Holy writer, but that their duty of prayer is

FIG. 3.



ROSARY OF THE ABBESS MARGUÉRITE AT EPERNAY, A.D. 1351.

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* The phrase "a pair of beads," meaning a rosary, is one of the few terms, which being lost to the language at large, have survived among English Catholics. It is used by Chaucer, and in old English wills it occurs again and again. Formerly a set of anything, whether the number were two or more, was commonly called a pair. We still retain the expression two pair of stairs, meaning two flights of stairs. The biographer of St. Hugh, of Lincoln, speaks of his receiving *duodecim paria literarum*, meaning twelve separate missives.

† Another instance of a rosary so divided, evidently by intention, and not by the carelessness of the lapidary, occurs in the tomb of Lord Beauchamp.

sufficiently satisfied by meditation on some word or phrase of the psalms, or any pious topic, whilst the words are sung aloud, so the simple peasant was taught, while saying his tale of *Aves*, to meditate devoutly upon some incident in the life of that Blessed Son whom the Virgin Mother thus saluted had brought into the world. This general feature of 150 salutations to our Blessed Lady, accompanied at least in a vague sense by the recalling to mind of the mysteries of our Redemption constitutes the essence of the devotion and was present I think from the beginning.

It is easy to talk of vain repetitions, but I may perhaps be pardoned for saying here that these do not seem to me more vain or meaningless than many things we are agreed in approving. I think it would surprise those who may have never come into contact with a devout peasantry, how little of superstition, and how much of what is best and truest in Christianity is fostered by the quiet and oft-repeated telling of the beads. In later times, the devotion of the rosary has crystallised into certain set forms. The whole number of 150 *Aves* is divided into fifties, and then again into tens, and between each ten Hail Mary's is repeated an Our Father, preceded by the Doxology. This Our Father is represented usually in the string of beads, by a bead of larger size, each decade being thus separated from its neighbours. Moreover, corresponding to each of these decades a definite subject of meditation or "mystery" is set down, the fifteen mysteries being divided into five joyful, five sorrowful, and five glorious, which follow in chronological order. The "five joyful mysteries" are the "Annunciation," "Visitation," "Nativity," "Presentation" and "Finding in the Temple," all of them, of course, scenes in the gospel history which occur repeatedly in mediæval art. The sorrowful mysteries are concerned only with the Passion. They are the "Agony in the Garden," the "Scourging" the "Crowning with Thorns," the "Carrying of the Cross," and the "Crucifixion." The glorious mysteries are the "Resurrection," the "Ascension," the "Descent of the Holy Ghost," the "Assumption of our Lady," and the "Coronation of our Lady in Heaven." This definite arrangement of mysteries, however, is of very late introduction. The earliest book which I know containing preciseiy these subjects in this exact order is a Spanish volume printed at Seville in 1495.*

A somewhat earlier work, approximating closely to this scheme, and founded on the writings of Alan de Rupe, was first printed at Ulm in 1489*; but in place of the Coronation of Our Lady, "the Last Judgment" is there assigned as the fifth of the glorious mysteries, and is depicted in a woodcut, as we shall see, after a type very familiar in mediæval art.

So far as my researches enable me to judge, all these arrangements of 15 definite mysteries are comparatively late, and do not occur at an earlier date than the last quarter of the 15th century. The earlier and more widely accepted practice was to assign an incident of our Lord's life to each of the fifty Hail Marys, and to add some little clause commemorating the incident to the words of the Hail Mary itself. This practice, I venture to think, must have had a considerable influence upon the art of the wood engraver at the time of the Rennaissance. With the introduction of printing a very large number of rosary books were produced, meant for the most part as aids to the devout to help them in their meditations. In the more sumptuous of these a different wood-cut is provided for each of the fifty, or, as the case may be, for each of the one hundred and fifty Hail Marys. The range of subjects extended from the conception of Mary to her death and coronation, and included, of course, the whole of the life of Christ. In this way a number of Gospel scenes came to be treated which are of very rare occurrence in art at an earlier epoch, and the variety thus introduced must have done something towards the deformalising and deconventionalising of the treatment of gospel subjects. One of the most elaborate of such rosary-books is probably that of Herman Nitzschewitz, which was undertaken at the command of the Emperor Frederick III., was printed at the Cistercian Monastery of Zenna, in the diocese of Magdeburg, and dedicated after Frederick's death to the young Maximilian. The woodcuts, of which there are a large number, are often grotesque and extravagant, but they are decidedly interesting to the student of religious art and symbolism. Each Hail Mary is illustrated by a scene from the Gospel, in which is inset a very minute cut, duly described in the letterpress, and referring to some Old Testament "type." Those who are acquainted with the mediæval mystery plays, or with the survival of this ancient institution, still to be witnessed at Ober Ammergau, will remember the prominence everywhere given to these Old Testament "types." No one who habitually recited his rosary after the manner suggested by Nitzschewitz could fail in a short time to acquire a wide acquaintance with all the most striking episodes in the Old and New Testaments.

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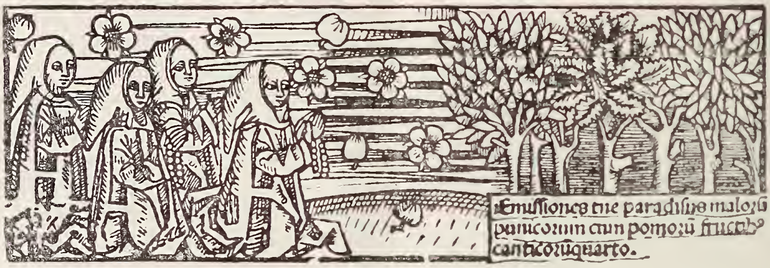
* Gorricio, "Contemplaciones sobre el Rosario."

* "Unser lieben Frauen Psalter." There were many editions of this little work, but in German, at any rate, no earlier text seems known than that of Dinckmut, Ulm, 1489.

It would take a great deal too long to give details regarding the many pictorial rosary-books produced in the Netherlands between 1478 and 1535. I will only refer to one of rather late date, which appeared with the same series of 50 woodcuts, not only in Latin and Flemish, but also in English. It was called "The Mystik Sweet Rosary of the Faythful Soule," and was published at Antwerp in 1533 by Martin Keyser, or, as his name appeared in a gallicised form, Martin Lemperour. The woodcuts, though small, are of a high order of merit. But the most famous of rosary-books, one which appeared in a very large number of editions, and which, as I gather from a recent catalogue of Quaritch's, still commands high prices, was probably that of the Dominican Alberto de Castello* which was printed at Venice in 1522. Like the others I have mentioned, it supplies a picture for each bead or Hail Mary, but being later in date, it reconciles this arrangement, which the earlier books do not, with the division of the whole rosary into the modern fifteen mysteries. I am rather at a loss to account for the value set upon the book, for its engravings are not very remarkable, but it went through a number of editions, and when the blocks became too worn for further use, a completely new set were engraved on similar lines.

FIG. 4.


Emissiones tue paradisus malorũ punicorum cum pomorũ fructib⁹ canticorũ quarto.

CARTHUSIANS SAYING THE ROSARY. A BORDER FROM NITZSCHEWITZ, "NOVUM B. VIRGINIS ROSARIUM," ZENNA, 1492.

There were many more such books, but we must hurry on; and I have barely time to mention the large engravings destined to commemorate the Rosary* by Erhart Schön and other artists, or the picture painted by Albert Durer, representing Our Lady of the Rosary with the Pope and Emperor and St. Dominic, a picture destined originally for a confratenity of German merchants residing in Venice, but which is now preserved at Prague. A word, however, must be said of the famous Rosary Tablet at Nuremberg, carved by Veit Stoss, of which a plaster cast is to be found at the South Kensington Museum. With the kind permission of the director, a friend has taken for me an admirable photograph of this cast, which I hope to show on the screen. Unfortunately neither the original at Nuremberg nor the South Kensington reproduction represent the complete work. The cross within a circle of 50 roses which forms the centre, was originally surrounded with a series of small bas-reliefs corresponding to the clauses or mysteries which the faithful were to meditate upon successively as they repeated the 50 Hail Marys. The series begins with the creation of Adam and Eve, and it ends with the last judgment. Unfortunately six of the bas-reliefs have been removed, and are now at Berlin. Let me add here that an even older and more widely spread subject of meditation when saying the five decades of Hail Mary's belonging to the rosary was suggested by the five Sacred Wounds. I say more widely spread because the pictorial representations of these in connection with the rosary are extremely common, whether we consider large sculptures and altar pieces or small engravings. The most frequent type represents a garland of fifty roses divided into tens by five larger roses, upon which last stand embossed the right and left hand, the right and left foot, and finally the pierced heart of Christ representing the wound in His side. German examples are plentiful*, and for an English instance I may refer to a quarrel of stained glass at Raby Castle, which is supposed formerly to have belonged to Whitby Abbey. Numerous little woodcuts, containing the shield of the five wounds, are met with in rosary books, and sometimes we find a rose in the centre, with a wounded heart displayed upon it, and the hands and feet in the corners.

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* "Rosario de la Gloriosa Vergine Maria."

* The letterpress in some of these prints seems to indicate that they were intended to be framed and hung up in the Chapel of Rosary Confraternities. In the Bodleian Library is a large broad-sheet printed at Memmingen, in 1506, containing a long set of verse directions for the saying of the Rosary.

I have been amused lately to find that a very much worn block of this kind, which has somehow been used as a tail-piece in one of the works of Francis Bacon, has been claimed as a proof that the printing of his books was in the hands of the Rosicrucian brethren, familiar with his cipher methods. These ciphers, says Mrs. Pott, the foundress of the English Bacon Society, the printers, banded together in a secret society, go on using to this day. It may interest some of my present hearers to learn that on the cover of the *Journal of the Society of Arts*, June 28th, 1895, we may read (in cipher presumably) the following words, "Francis Bacon, Viscount St. Albans, Lord Verulam, Shakespeare, instituted the Society of Arts in London for the good of English Commerce." So at least Mrs. Pott informed the Bacon Society in a paper read before that body and published in their journal shortly afterwards.†

But to return from this digression, the garlands of roses which are a conspicuous feature of nearly all these pictures and tablets of the 15th century imply, of course, a reference to the now generally accepted name of the devotion, the *Rosary* (*Rosenkranz*) as to which name I have as yet said nothing. To determine at what date it was introduced seems extremely difficult. No clear example of it, as a name, seems to occur before the 15th century. The beads themselves bore many appellations, "paternoster" being the commonest, but they were not called rosaries. *Rosarium* is, no doubt, *rosarium* (*sertum*), wreath of roses, the corresponding words "chapelet," "corona," "rosenkranz," "capellina," all convey the idea of garland. At that epoch it was common to an extent which we have now great difficulty in realising, for both men and women in ordinary life to wear garlands of flowers, and to place such garlands as a mark of respect upon the heads of persons and statues. It would be easy to illustrate this from Chaucer, and the metrical romance writers, whether English or French, but the strongest evidence comes from quite prosaic sources.

The *chappelliers* or makers of head-gear of Paris, as we learn from Boyleau*, included not only workers in felt and cotton, but also *chappelliers de fleurs*, whose business it was to make flower garlands for actual wear. Amongst their statutes, which are drawn up as formally as those of any other trade, it is stated that they are forbidden, under a heavy penalty, to work at their garlands on Sundays, except that while the rose season lasted they might occupy themselves on that day in making rose wreaths, though they were not free to make any other kind. So we find St. Louis, King of France at the same period, passing an ordinance that rose garlands were not to be worn on Fridays. The idea of rose garlands was, therefore, very familiar, and although I am aware that *Rosarium* was not uncommonly used in the sense of what we should call an anthology or collection of choice extracts, I am strongly inclined to believe that its application to the particular devotion now under discussion was mainly due to the wide prevalence of one particular story of a garland which we can trace very much earlier than the word itself in almost every part of the Christian world. The name, it seems to me, must have come from the story, and the story was not, as we should at first be tempted to think, evolved out of the name already pre-existing.

The legend in question, which occurs with slight variations in many of those quaint collections of "Miracles of Our Lady," that were so popular in the Middle Ages, is briefly this: A youth was accustomed to make a wreath of roses or other flowers every day, and to place it upon the head of Our Lady's statue. He became a monk, and in the cloister his occupations no longer permitted him to observe this pious practice. Being much distressed, he asked counsel of an aged priest, who advised him to say 50 *Aves* every evening (in some versions it is 150, in others 25), which would be accepted by our Lady in lieu of the garland. This the young man faithfully observed, until one day, being upon a journey, he had to pass through a lonely wood where robbers were lying in wait. They were employed in watching him, feeling sure of their prey, when he, unsuspicious of their presence, remembered that his *Aves* were not yet said, and forthwith stopped to say them. Then to their surprise, the robbers saw a most glorious lady stand before him and take one after another from the lips of the kneeling monk, fifty beautiful roses, which she wove into a garland and placed upon her head. The robbers, so the legend tells, conscience-stricken at the vision, were all converted to a better life, and themselves soon after entered the monastery.

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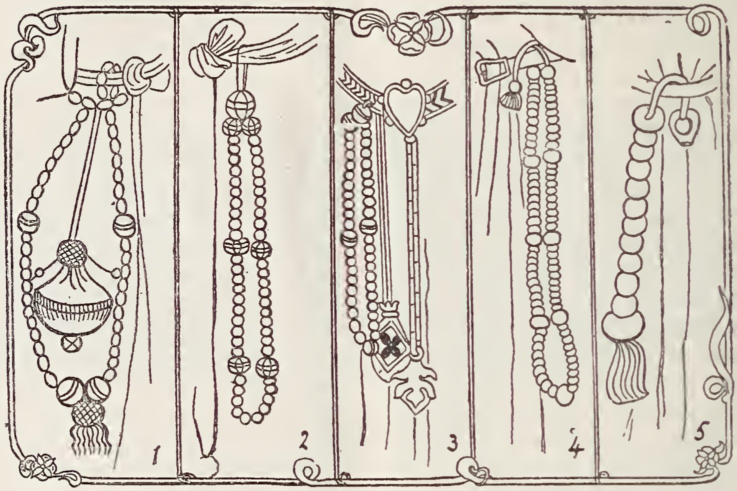
* *E.g.*, at the Abbey of St. John Schleswig, at Lübeck, Neukloster, &c. See "Zeitschrift für Christliche Kunst," 1900, p. 36.

† "Journal of the Bacon Society," Sept. 1895, p. 120.

† Boyleau, "Liure des Métiers," p. 198.

FIG. 5.



ROSARIES FROM 15TH CENTURY NORFOLK BRASSES.

Now this story meets us in every part of Europe at a very early date. Perhaps the earliest clear instance is in a collection of German popular poetry assigned to about the year 1236. Before the end of the same century we find it told by King Alfonso the Wise, King of Castille, in his "Cantigas de Santa Maria." It occurs also in several 13th century Latin collections of the miracles. Then in the 14th century we find it in Mielot's French prose narrations, and it was also dramatised and is included amongst the interesting French miracle plays, edited by M. Gaston Paris. In the 15th century we meet the story again, with slight variations of detail, told both in Germany and in Spain as the history of the true origin of the rosary, but, most curious of all, we find that it has by that time penetrated into far off Abyssinia, almost as remote a spot, one might think, as it was then possible for any Christian legend to reach. Amongst the spoils brought back by Lord Napier's army from Magdala in 1867, were some extremely valuable Æthiopic manuscripts, now in the possession of Lady Meux. They are illustrated with miniatures, and coloured gorgeously, but in somewhat barbaric taste. These codices supply important evidence regarding the art of Æthiopia in the early stages of its development. But the contents of the volumes are also interesting. They preserve collections of the miracles of Our Lady, so well-known in the West for many centuries before, and amongst these we meet our legend of the rose garland, unchanged in substance, though now told of a cleric of Rome named Zacharias, the leading details of whose history are elaborately illustrated in the miniatures, as I hope shortly to show you. Whether the use of the rosary itself was familiar in Abyssinia in the 15th century, I am unable to say, but the Meux manuscripts prove that it was regarded as a conspicuous adjunct of religious life there a century or two later.

Taking the term rosary, as is usually done, in its wider acceptation, so as to include all forms of praying beads—need I say that the word "bead" itself originally meant a prayer—it is remarkable what very great variety we observe in mediæval rosaries. The rosaries themselves have not been preserved to us. I know of no specimen certainly older than the year 1500, and at an exhibition at Limoges, some few years back, in which an attempt was made to bring together some ancient examples nothing could be procured which was of earlier date than the 16th century. None the less we know them from pictures and especially from the careful and elaborate representations on tombs, as well as from the details given in inventories and wills. Before 1450, sepulchral effigies with rosaries are distinctly scarce. There are many hundreds of drawings of early mediæval tombs in the Gaignières collection at the Bodleian, a collection of drawings made in France long before the havoc wrought by the Revolution. I have found amongst them only one 14th century tomb with a rosary. But in the few extant early examples, whether in this country or abroad, there is the greatest possible variety. Two 14th century examples of effigies—one at Bangor, and the other at Worcester—show rosaries divided into sevens or sixes. A figure of a mourner at Warwick (c. 1430) exhibits a rosary in nines. Some early French and German examples are carefully and intentionally divided into fives or sevens, and elsewhere we count 75 beads, or 80 beads, or 40 or 33 often without divisions of any kind. One type of arrangement, consisting of six decades, with a pendant of three extra beads, appears in the 15th century, and became very common in the 16th and 17th, especially in France and at Rome. It was distinctively called the *corona*, and was probably intended to honour the 63 years assigned by legend as the years of Our Lady's mortal life. I attribute to this form the prevalence of the pendant ot three small and one large bead seen in nearly all modern specimens. One of the earliest examples I know of a pair of beads exactly agreeing with the modern type, is the Duke of Norfolk's magnificent golden rosary which belonged to Mary Queen of Scots, and which at the present moment is being exhibited at the New Gallery. In the Bangor effigy, which shows 84 small beads divided into sevens by larger beads, three large brooches and what seem to be two rings are also attached to the rosary. One is reminded of Chaucer's Prioresse :—

> "Of smal coral aboute hir arme she bar,
> A peire of bedes, gauded all with grene,
> And theron heng a broche of gold ful shene,
> On which ther was first write a crowned A,
> And after : *Amor vincit omnia.*"

It is dangerous to begin to quote inventories, the series would be endless. But I note that in the inventory of plate and jewels of Charles V., King of France, in 1380, there are entered 19 rosaries *(patenostres)*. These, as regards material, were made of rose-tinted amber, jet, coral with pearls for markers *(seignaulx)*, gold beads, rings of gold, blue and white enamel, jet beads with 11 gold *croizettes*, black amber and pearls, coral alternating with beads of silver-gilt, and two instances of gold beads of Damascus work, which were filled with musk. Various objects are also mentioned as suspended from the beads themselves, *e.g.*, cameos, brooches, a stud (*bouton*) or pendant of pearls, five *frezettes* (ruffs ?), a little lozenge set with pearls, and on the same rosary a *croizette* of coral and a crucifix of gold. As regards the number of the beads, which is not always mentioned, there are one or two instances in which the normal type, as we should now consider it, of fifty smaller beads, with five larger beads, or five *seignaulx* is specified, but in other cases we find rosaries of 200 gold beads, one of 50 beads with eleven *seignaulx*, one of 62 beads in all, one of 75 beads, and other smaller ones of twelve or less.* So again, in the inventory of the Princes of Orléans-Valois in 1408, we have one rosary of amethists and jasper with a *bouton* or stud of pearls, another of jet, with nine little bells (*dandins*) of gold, and a jewel with nine pearls as a pendant, and another again of jet, with nine gold *saingnaulx* and a gold figure of St. Christopher attached.†

There can, of course, be no doubt that such rosaries were quite as much used for personal adornment as for purposes of devotion, with the result that these objects of piety were not overlooked in the sumptuary laws which strove to check the unbecoming extravagence of the burgher class, especially in Germany. The Police Ordinances of Nuremberg, for instance, in the 13th and 14th century, forbid the using of paternosters of above a certain value, and give curious and minute instructions as to the manner in which they should be worn. Similarly the Municipal Council of Regensburg, in 1485, amongst other attempted restrictions on habits of luxury, decreed that no one should possess more than three or four rosaries, and that these should not be of the value of more than 10 *gulden*. As three fat oxen could then be purchased for

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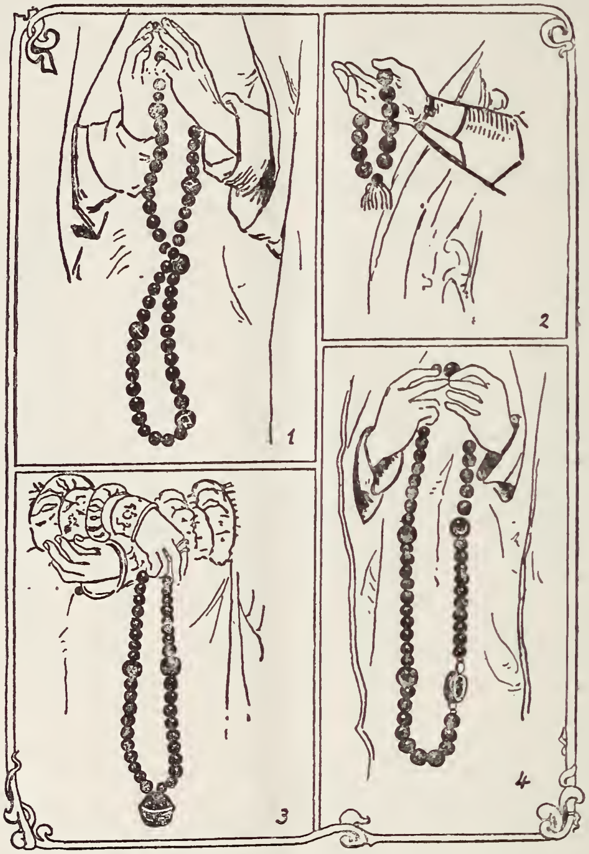
* Labarte, "Inventaire du Mobilier de Charles V."

† Roman, "Inventaires et Documents des Princes d'Orléans-Valois."

12 *gulden*, this seems a pretty generous allowance.*

Fig. 6.



German Rosaries from early 16th Century Brasses at Meissen.

One would like to know a little more about the workmanship expended upon these articles of luxury, but the objects themselves have disappeared, and the guild statutes collected by Boyleau tell us very little on this head. The beads do not seem to have been wired, but simply perforated and strung upon a cord. This, no doubt, accounts in large measure for their complete disappearance. The jewels have simply been released from their cord, and used for necklaces, bracelets, and other purposes. An incident in Rabelais lets us know that it was an easy thing for a malicious person to cut the string of a lady's rosary, and to pocket the beads which came tumbling down. The only objects belonging to these mediæval rosaries which have been at all extensively preserved, and which we can now recognise as having served for this purpose, are the marvellous spherical box-wood carvings, which at the end of the 15th and the beginning of the 16th century were used as pendants to hang from the more sumptuous kind of bead chaplet. These pendants or nuts vary in diameter from one to three or four inches, and the carvings also, though such scenes as the Crucifixion or the Nativity often recur, show much diversity, and are by no means always connected with the "mysteries" of the rosary. Several fine specimens belonged to the Spitzer collection, and M. Arthur Pabst, in a detailed notice of this section, speaks as follows:—"A special place in the history of sculpture ought to be reserved for these tiny objects, which are called in French *grains de chapelet*, and which are known in Germany as 'prayer nuts' and "paternosters." They belong to that section of devotional art which was so earnestly cultivated by artists at the close of the Middle Ages. These rosary beads carved in boxwood and spherical in shape, are often enclosed in an open work case, or sometimes with two such cases, one outside the other. The bead opens with a hinge, and displays two hemispheres, in the hollow of which are carved two scenes, generally composed of a large number of figures.

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* Janssen, "Geschichte des deutschen Volkes," 9th Edition, vol. 1, p. 377. The English *Kalender of Shepherdys of* 1506, in a catalogue of sins, speaks of the vanity shown—

> "In jewels, rynges, signettis and ouches,
> In orecyousnesse of gownes, gyrdels and bedis."

Often we find a flat moveable disc separating the two halves, itself covered on both sides with delicate carving. Executed as they are with extraordinary skill, these groups which are often cut in high relief and completely detached from the background are no doubt *tours de force*, and are not free from a certain exaggeration; but for all that, there is much in the attitude and pose of the figures which betrays the hand of the true artist. These carvings are probably of Flemish origin, but they may have been wrought under the influence of masters of North Germany in the 15th century. It is quite likely that they all come from a very small number of workshops, and the fashion certainly did not last for more than a hundred years. To judge by the architectural details in the carvings and from other indications, all that are now in existence, were probably produced in Flanders between 1475 and 1530. Flemish portraits, (there is one for instance in the museum at Brussels), of this period sometimes show a decade of beads, at the end of which may be recognised one of these large spherical boxwood nuts. The most magnificent specimen now in existence is probably that in the possession of the Duke of Devonshire, which is said to have belonged to Cardinal Wolsey, and to have been given by him to Henry VIII. In the terminal bead, four inches in diameter, twenty-four different scenes are elaborately carved. Three or four fine specimens are in the Waddesdon collection lately presented to the British Museum, and by the kindness of Mr. Read I have been able to obtain photographs of two, which will be shown on the screen.

There are many other aspects of the subject, which invite further discussion, but my paper is already too long, and I will take my leave here.

DISCUSSION.

The CHAIRMAN, in inviting discussion on the paper, said that before coming to the meeting, the audience might have thought that the topic to be treated by Father Thurston would present nothing but a dry and technical discourse upon matters of antiquity, but he had managed to throw into his antiquarian investigation a degree of interest with which he (the Chairman) did not expect to find it adorned.

Sir GEORGE BIRDWOOD said:—He felt quite unworthy of the duty which fell upon him, as Chairman of the Applied Art Section of the Society, of rising and expressing the thanks of the Section to the Reverend Father Thurston for the interesting and valuable paper just read before them, and their grateful acknowledgments of the honour shown them by the presence of His Eminence Cardinal Vaughan in the chair. He therefore congratulated himself that His Eminence and Father Thurston could not but perceive that the substantial and unimpeachable recognition of the favour they had conferred on the Section, in the influential character of the audience which was there to welcome them, and which had given them so brilliant and enthusiastic a reception. They had profoundly appreciated, not simply the convincing erudition and historical importance of a paper which would remain the classical authority on its subject, but its attractive persuasiveness,—that compelling charm of all learning and scholarship, and science and art, when devoutly consecrated to the highest service of humanity. He could not forbear pressing this point, for he had ever in that place, and in all his humble writings on Indian art, protested against art being regarded—as it is by those modern apostles of "æsthetic culture" who falsely believe themselves to be desciples of Goethe, and Winckelmann, and Emerson, and Matthew Arnold—as its own end, and in any sense self-sufficing. The distinctive note of the highest art is that at a glance it spiritualises sense, and at once raises the heart of man above himself, in spontaneous, over-mastering adoration of the author and finisher of every perfect work. Mrs. Siddons, when first she beheld the Apollo Belvidere, could not suppress the religious emotion the sight of it aroused in her, exclaiming:—"How unimaginable the glory of God when one of his creatures is found capable of fashioning a form so glorious!" It is the instinctive thought to which Milton gives expression in the morning hymn of our first parents while yet in Paradise:—

"Thine this universal frame,
Thus wondrous fair; Thyself how wondrous then!"

The thought may be inspired either by the devout intention of the artist, or by his loyalty to his artistic conscience; but it is never inspired except by the artist's religious reverence, or his moral earnestness, which is, after all, another form of devout aspiration.

> "Not from a vain or shallow thought
> His awful Jove young Phidias brought."

And again quoting Emerson:—

> "The hand that rounded Peter's dome,
> And groined the aisles of Christian Rome
> Wrought in a sad sincerity.
> Himself from God he could not free,
> He builded better than he knew,—
> The conscious stone to beauty grew."

This suggestion of a participation of the shews of things in divineness is the note of art everywhere in India, even in its most homely manifestations, and simply because in all its applications it reflects the universally operative belief of the Hindoos in the sacramentality of life, and of all existence. "Religone vita constat" says Pliny. Nothing can be simpler than the art of the Hindu rosary, the Saiva rosary of 84 beads, and the Vaishnava of 108; but when you learn that the sacred number 84 (*chaurasi*) is made up of the number of the 12 signs of the zodiac, multiplied by the number of the 7 planets; and that the sacred number 108 is similarly made up, the moon being counted as 3—the rising, full, and waning moon—instead of 1, then you understand that every Hindu rosary symbolises the whole circuit of the hosts of heaven; and this knowledge thenceforth transfigures them in your eyes. He was satisfied, from the numbers of the beads strung on them, and their mode of division, into 12 groups of 7, that the earliest Christian rosaries, like the Baudha and Islamitic rosaries, were originally derived from the rosaries of the Hindus. In the lantern slide which reproduces one of Lady Meux's Æthiopic MSS., all the objects represented in the hands of the saints—the pastoral staff, the aspergillum [or is it a "muscarium?"], and the rosary, are exactly of the same form as those seen to this day in India; the pastoral staff being identical with the crutch-handled staff ["litnus?"] of the rajahs, and certain classes of religious mendicants of India, and habitually used by them, when seated cross-legged, as arm-rests. The Spanish rosary shown, in which every bead was carved in the similitude of a skull, had assuredly been suggested by Siva's own rosary of skulls. If he was indeed right in this, then the Christian rosary also refers ultimately, through "the dark backward and abysm of time," to the shining heavens, as the celestial rosary, hanging eternally from the hand of their Almighty Maker. A tradition of Mahomet states that on being shown a garland of roses, he observed: "Every flower in the garden of God, is an Alleluia!" And it is in this worshipful spirit that, in the Christian rosary, however simple, or however elaborated by the jeweller's beautiful art, every bead—[this word itself meaning, as Father Thurston has told us, "prayer"]—is an "Ave!" or a "Pater." He would not discuss the Reverend Father's paper; it was beyond all criticism that he could offer on it. He could only express his great gratitude for it; and frankly, his gratitude was a sense of further favours from him in the future. It was contrary to the tradition of the Society to accord any formal vote of thanks to the Chairman at their meetings, but the circumstances of that afternoon were so exceptional that he felt it his duty to the audience, before moving their vote of thanks to the Reverend Father Thurston, to convey to the Cardinal Vaughan the renewed expression of their most respectful and grateful sense of the honour he had done both to Father Thurston and themselves, by his gracious occupation of the chair on the present occasion, to which his presence indeed gave its highest distinction. For his own part, he could not but contrast the serenity of their meeting there that afternoon, with what was going on at the same hour at another meeting elsewhere; and the antithesis gave a newer and more significant meaning to those noble words, again, of the elder Pliny:—"Immensa Romanæ pacis majestas."

The Chairman, in putting to the meeting a vote of thanks to the reader of the paper, said he was sure there was no one present who would not feel that the vote had been thoroughly well earned by Father Thurston. Personally he felt he had been greatly honoured by being invited to preside in a hall of such renown, which had taken so important a place in the life of Art in this country, as the hall of the Society of Arts.

The resolution was carried unanimously; and having been briefly acknowledged by Father Thurston, the meeting terminated.

ELEVENTH ORDINARY MEETING.

Wednesday, February 19th, 1902; General Sir George Wentworth A. Higginson, K.C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Apostoloff, Serge B., 28, Bush-lane, E.C., and 8, Victoria-square, Grosvenor-gardens, S.W.
Finzi, John Abraham, 53, Hamilton-terrace, N.W.
Hunter, Summers, M.I.N.A., North-Eastern Marine Engineering Co., Ltd., Wallsend, Newcastle-on-Tyne.
Page, Davidge, A.I.E.E.. Hotel Russell, Russell-square, W.C.

The following members were balloted for, and duly elected members of the Society:—

Barringer, Herbert, M.I.N.A., 78, Gracechurch-street, E.C.
Garnett, Tom, Radeclyffe, Clitheroe.
Hall, Prof. Charles James Sculthorpe, F.R.I.B.A., Apartado 99, Puebla, Mexico.

Herdman, George Walker, M.A., B.Sc., A.M. Inst.C.E., 2, Fyfield-road, Enfield, Middlesex.

Khanji, Prince Yaver Hussain, The Palace, Palanpur (R.M. Railway), India.

Lubeck, Luiz Adolpho, 2, Canton-road, Shanghai, China.

Wood, Ernest Seymour, F.G.S., 5, Fairlie-place, Calcutta, India.

Wurster, Dr. Casimir, Dudley-mansions, 29, Abbey-road, St. John's-wood. N.W., and KaiserFriedrich-Platz 2iv, Berlin, Germany.

The paper read was—

THE USE OF BALLOONS IN WAR.

By Eric H. Stuart Bruce, M.A.

The object which stimulated the practical invention of the balloon was its use in war. I say practical invention, because in theory the balloon dates back as far as the elucidation of the principle of the pressure of fluids by Archimedes of Syracuse. But it was its use in war which fired Montgolfier, the paper-maker of Annonay, in 1773, to fill his paper bags with heated air, and Charles, the Parisian, in the same year, to eclipse the fame of the former by the invention of the gas balloon.

Ten years after the experiments of Montgolfier and Charles, balloons were first used in warfare by the French Government for the very same purpose as that for which they have been used in the South African War, viz., for taking observations of the position and movements of the enemy.

It was Guyton de Merveau who first suggested their use to the Committee of Public Safety, and the first experiments were so successful that a regular company was formed, called "Aerostiers," and the School of Ballooning established at Meudon. The picture on the screen represents the operations of the Aerostiers. The first military balloon made was called the "Entreprenant." This was used at the sieges of Maubeuge and Charleroi, also at the battle of Fleurus. On this latter occasion it is recorded that the balloon remained in the air ten consecutive hours, every movement of the enemy being seen and signalled. It was again used at the siege of Mainz. In 1796, the French Government manufactured some more war balloons, which were sent to the armies of Düsseldorf and Stuttgardt. Altogether, it would seem that better work with captive observation balloons in war was done at that early period than during the whole time which elapsed between those wars and the South African campaign. This, without a doubt, forms the greatest object-lesson of the use of captive balloons in war on record

It was Napoleon the Great who disbanded the two balloon companies which had been formed, closed the school at Meudon, and sold the balloon material. Carnot used a captive balloon at the siege of Antwerp in 1814, and another was used in 1859, on the eve of Solferino. In the Civil War in America, a regular balloon service was organised, as also in 1866, in the war between Paraguay and Brazil. During the siege of Paris, in 1870-71, the use of free balloons in war was successfully demonstrated, and to this use I will later specially refer. Since that date military balloon establishments have been founded in most European armies and in America. Balloons were used by the French in the Tonkin Expedition of 1882, and at Bac-ninh and Hoang-ho in 1884. In the Madagascar Expedition, in 1895, a balloon party was taken out, though no actual use appears to have been made of the balloon in that campaign. It is, I think, not generally known that before the present South African campaign the balloon was used in South Africa in 1884, when the late Colonel Esdale and Major Trollope made several ascents in the now historic Mafeking.

There could have been no better opportunity for displaying the value of the balloon as an adjunct of war than the fierce campaign which has been in progress in South Africa. Its use in one position alone, that of Ladysmith, has justified the expenditure that our Government has sanctioned in forming what is undoubtedly the first military balloon equipment in the world. To reconnoitre the enemy is the principal use to which balloons are at present applied in the British army. Critics may, perhaps, have wondered why other developments of balloons have not been evolved by our national aeronauts; why, for instance, there have not been experiments with navigable balloons, or rather balloons so far navigable as to combat very light winds, as did Captains Krebs and Renard, in 1885, with their balloon "La France," or M. Santos-Dumont with his "No. 6," last summer. But we have not far to look for reasons for the omission of the endeavour to extend the balloon service beyond mere reconnoitering. It must be remembered that the balloon section of the British army as it exists to-day is of comparatively modern date, that a few years ago the balloon service in our army was only represented by a balloon committee, who were much handicapped by the slenderness of the grants they received for carrying out their expensive experiments. During the years 1885 and 1886 so much scepticism as to their utility existed that fears were entertained by some as to the ultimate position of the British war balloon. But the power of individuality saved the situation. Fortunately for the balloonists, the Inspector-General of Fortifications at that time was General Sir Andrew Clarke. It was his keen-sightedness that foresaw the day when the country would need her balloon eye. It was his enthusiasm that won for the aërial experiments fairer consideration and ampler funds, until repeated experiments on field-days and in manœuvres gradually dispelled prejudice and scepticism, and secured for the balloons a decisive recognition. When more adequate grants first came to hand it was expedient to expend them on mere necessaries, for instance, to replace the sheds in which the balloons were made and stored at Chatham by the spacious factories and balloon-house now erected at Aldershot. The experts, in concentrating their past efforts on one important and practical branch of military ballooning, and making that as perfect as possible with the means at their disposal, displayed wisdom, though doubtless they will not hesitate to extend their efforts to other branches of ballooning, provided they are amply supplied with the sinews of experiment.

Perhaps the strongest point concerning the national balloon equipment is the material out of which the balloon is constructed, viz., goldbeaters' skin. The adoption of this material was nothing short of a stroke of genius on the part of Colonel Templer and the other officers associated with the balloons, and on the fact of its adoption depended the success of the balloons in the South African War. For some time past toy balloons had been made of this material, and sold in abundance by opticians; but to our Government belongs the honour of making large balloons, to carry passengers, of this material. A fine photograph of the British goldbeaters' skin balloon is before you on the screen. Next you see the balloon in mid-air. Balloons made of goldbeaters' skin have the advantage of retaining the gas much longer than balloons made of varnished silk or cambric, for there is no varnish in the market that is so successful in retaining the subtle hydrogen, or near the mark in accomplishing this. There is a tradition on the Continent that, in the early days of ballooning, there was a fairly gas-proof varnish, and that the secret was lost. If so, the chemist may do a real service to aeronautics in re-discovering it. Another advantage of goldbeaters' skin balloons is that they do not easily heat, while the ordinary cambric balloons are notorious for heating or getting sticky. The former can be used with much greater safety in hot climates. In the issue of the *Aëronautical Journal* for October, 1899, extracts from the official report of Lieut.-Colonel J. E. Maxfield, United States Volunteer Signal Corps, to the Chief Signal Officer United States, are quoted, under the title "War Ballooning in Cuba" (p. 83). It is related how the United States Corps, when they wanted to use the old balloon after the landing of the troops at Daiquiri, found that the extreme heat had softened the varnish so as to cause the parts of the envelope to stick together, with the result of scorching, which rotted the balloon. This scorching is almost an every-day occurrence with balloons made of varnished silk or cambric if they are packed up without attention. Their manipulation requires the utmost care, which in transport cannot always be afforded. Even during manufacture an ordinary varnished balloon may burst into flame if the weather is fairly hot and the ventilation of the factory insufficient. I have myself seen the partial destruction of a balloon of 100,000 cubic feet capacity in a few moments during its manufacture on a warm, spring day, in too confined a space. A third but all-important advantage of the goldbeaters' skin balloon is its extreme lightness compared with balloons made of other materials. Here I have a small balloon made of goldbeaters' skin. If this balloon was made of ordinary material, varnished cambric, the gas contained in it would not lift its own weight; make it ten times the size, and it would remain a dead weight; but made of this light material, it rises to the ceiling of the room. Thus the use of goldbeaters' skin secures a much smaller-sized balloon for a given lighting power than does varnished cambric or silk. In reference to the report above quoted, Lieut.-Colonel Maxfield came to the conclusion that balloons employed in military reconnaissance should be at the least 18,000 cubic feet capacity; but our British war balloon can be only of 10,000 cubic feet capacity, and thoroughly efficient. The reduction in the size of the balloon by the use of goldbeaters' skin does not only reduce the size of the balloon, but also the weight of the balloon equipment, when cylinders of compressed gas are taken out to the field of operations, for filling the balloons. According to figures quoted by Lieutenant Jones, in a lecture he delivered at the Royal United Service Institution, the balloon of 10,000 cubic feet capacity would require only about 84 steel tubes to fill it, each of these being about eight feet long, and 5⅝ inches in diameter, containing 120 cubic feet of gas, and weighing 70 lbs. If, on the other hand, a balloon of 18,000 cubic feet is used, as is officially recommended in the United States, the number of tubes required would not be far short of double the number.

A fourth advantage of the goldbeaters' skin balloon is strength. At first sight the material may seem too fragile, for most persons are familiar with goldbeaters' skin as the thin, transparent plaster which is used for a cut finger. But the desideratum of strength is obtained by combining layers on layers of the substance to any desired thickness.

The system adopted by our Government of compressing the gas in steel cylinders, and taking them to the place of operation, is undoubtedly handier than filling the balloons direct from the manufacturing apparatus, and by the cylinder method it can be done with far greater speed. To show how easily and quickly a balloon can be inflated from a cylinder, I will fill this small balloon before you.

As regards the actual operations with the balloons in the South African campaign, speaking as a civilian in the presence of military experts, I wish it to be distinctly understood that I speak under correction. To the best of my powers, I will put forward a few instances when I believe the British war balloon was of inestimable value. Before making these remarks, I will show you an excellent photograph of a balloon convoy crossing a river in South Africa, taken by S. W. Maxwell, of the *Standard*.

It was the Second Balloon Section that went to Ladysmith, and got up just in front of the sailors. The balloon observations were carried out at Ladysmith as long as the balloon and gas lasted, which was about 27 days. It has been said that our naval guns saved Ladysmith, but it must be remembered that they owed much of their success to the observer in the captive balloon. From his elevated position he could locate the Boer guns, and direct the operations of the British artillery with an unerring precision. A little to the right, or a little to the left, was often the message telephoned down to earth, and that little made all the difference in the accuracy of the artillery fire.

The presence of the balloon withdrew all the Boer fire on to the aerial target, so difficult to hit. Several balloons were, however, absolutely destroyed by shell fire. Once, I am told, a balloon was burst at Ladysmith when at a great height, and had a very quick run down. Regarding the question of the chances of a balloon being struck by the enemy, practical experiments at Lydd showed that a balloon may be almost riddled with bullets in its lower portion and remain in the air, owing to the upward pressure of the hydrogen gas. Some of the balloons at Aldershot that were returned from the war, show signs of the bullet perforation.

Here I have a small captive balloon. I perforate it over and over again in its lower portion. These holes correspond to so many bullet-shots in it, yet it does not fall but remains in the air. Artillery fire is more formidable; but it is not very easy to hit a balloon when at all high up, as it is difficult to establish the distance between the balloon and the gun, as well as not easy to obtain the required elevation of the pieces. In experiments at Lydd a 13-pounder field-gun was turned on to the balloon when it was 1,000 feet high at a range of 400 yards, and the balloon was not struck till the seventeenth shot. At Ladysmith, it is true, the Boers had the advantage of having the gun they usually used against the balloon posted on Umbulwana, a hill nearly 1,000 feet high, but all the same I am informed that they had a habit of firing on the balloon almost exclusively when it was at a short distance from the ground, some twenty to sixty yards elevation, on its ascent and descent. It was then more easy to get the range.

Captain Philip's balloon section also accomplished magnificent work with General Buller at Colenso, and up the Tugela River. At Spion Kop, it discovered that our army was going to march into a death trap. On reflecting on the narrow escape of a great disaster averted by the balloons at Spion Kop, the thought forces itself upon the mind what would have happened had it not been for that happy aërial observation at that critical moment? What might have been the effect of depression on our army, and exhilaration on the part of the Boers? I will not go so far as to hint that Ladysmith might have fallen, for the history of the sieges of Ladysmith and Mafeking show how difficult it is to find the limit of British endurance. But I will say that this brilliant achievement of the balloonists facilitated the relief of the hard-pressed garrison, Captain Jones' section went up with Lord Methuen on Modder River and the observations continued every day. In the opinion of experts there was not a single day that they were not absolutely of the highest importance. Lord Kitchener also used balloons, and it is stated that through information obtained by them the British army was enabled to march on to Pardeburg. At Pretoria too the balloon rendered the greatest service. It located the whole position and no chance was given for the enemy to escape. On this occasion the balloon worked for five days continuously and was shot in several places. Major Blake's section went to Mafeking, and there one of the most brilliant balloon exploits of the campaign was accomplished at Fourteen Streams. By the balloon observations taken at that point the Boers were prevented from relieving Fourteen Streams. In this case the balloon was worked for thirteen days continuously with one inflation. This was the best possible test of the efficiency of the retentive power of the goldbeaters' skin balloons. Much is said at the present moment about the backwardness of the British nation in aëronautical matters. In answer to such statements, I would express my opinion, that at the present moment, no other nation in the world could have produced a balloon of the same size, that could have thus worked for thirteen days with one load of gas. I am able to show you, by the kindness of Messrs. Underwood and Underwood, two very good photographs of the British war balloon at the front. The first shows Lord Roberts's army marching towards Johannesburg, the 84th battery and balloon corps, the second the balloon ready to ascend for observation with Lord Roberts's army advancing on Pretoria.

The nature of the climate and country in South Africa afforded some conditions that were favourable to the working of the balloon, others that were unfavourable. A favourable condition was the translucency of the atmosphere. A correspondent in the *Graphic* pointed out that the translucent South African atmosphere peculiarly lent itself to balloon observations; that in manœuvres in England the range of a balloon's effective vision at a height of 1,000 feet is not more than seven or eight miles, whereas in South Africa it is ten or twelve miles. A disadvantage of the climate would appear to be the strong winds that blow frequently and often in gusts. Wind is the bugbear of the captive balloon, and limits its general use. I may mention that as an attempt to increase the number of days upon which a balloon may be worked, the Germans invented the drachen or kite balloon, which is supposed to resist strong winds. The balloon is cylindrical with hemispherical ends, and is attached to its cable like a kite, so that the wind acts to lift and not depress it. The cylinder is divided by a diaphragm near its lower end into two chambers, the upper and larger one being filled with gas, while the lower chamber by means of a valve opening inwards receives the pressure of the wind which presses against the diaphragm and preserves the sausage-like form of the balloon in spite of leakage of gas. Another windbag encircling the bottom of the air-chamber serves as a rudder, and latent fins or wings give stability to the balloon about its longer axis. It would, however, be necessary that a series of comparative experiments should be carried out on the same days with spherical and sausage-shaped balloons before forming a definite opinion as to the advantage of the latter. At any rate the military experts in this country have not thought it advisable to discard the spherical balloon.

In South Africa, besides ordinary windy weather, there are frequent whirlwinds, or, as they are called, "devils." It appears that more than once the balloons were caught by these. A somewhat disadvantageous circumstance was the heights that had to be traversed. On the march to Pretoria there were hills 6,000 feet above the sea level. To make an observation on these hills the balloon had to ascend to some 2,000 feet, making the barometrical height 8,000 feet. This was a strain on the buoyancy of the balloons, and, in fact, they worked very near their possible limit.

Throughout the campaign the Boers absolutely dreaded the far-seeing eye of the balloon so opposed to their system of warfare. One of their prisoners is reported to have said, "If ever we catch the man in the balloon we'll make mincemeat of him. He is the one which does us the most harm. We could not move, we could not creep from one stone to another but he pointed us out, and we'll pay him out for it if we lay hands on him." I may mention, what I believe is not generally known, that the Boers had an offer from a foreign country, to be supplied with war balloons, but they refused the offer, saying that they would not know how to manage them if they had them. I should mention, that during the critical period of the war, the whole strain of supplying the balloons to the seat of war fell upon Major F. C. Trollope, who was in superintendence of the balloon factory at Aldershot. One of the greatest testimonies of the skill and resourcefulness of this officer was, that though the crisis in China came in the middle of the exigencies of the South African campaign, and necessitated a supply of balloons for that country also, he was still able to send a show balloon section to the Jubilee in Australia.

There is a use for the captive balloon in war besides observation, viz., for signalling. It has been my privilege to invent a system of balloon signalling, and to supply the apparatus to the British, Belgian, and Italian Governments, and I feel that it will be legitimate for me to say a few words upon this system, for the reason that, as far as this invention is concerned, commercial considerations have not been my direct aim. If the results of my experiments prove of use to the British Army in an emergency, that will be my reward.

The advantage of signalling from a balloon is the altitude obtainable. Any system of signalling can be used from the car of an ordinary captive balloon, such as flag or lantern signalling; but signalling from the car of a balloon necessitates the use of a balloon of not less than 10,000 cubic feet capacity, and a balloon of such a size entails the bulky transport of cylinders of compressed hydrogen gas. This fact limits the practicability of signalling from an ordinary balloon.

Some few years ago, it occurred to me to apply electric flash signalling to a captive balloon so that the operator and most of the apparatus may remain on the ground. In this system, since the weight of the car and operator is abolished, the balloon can be of such a size as to be portable, quickly inflated, and easily manipulated. The details of this system are well known. In the interior of a balloon made of translucent material are placed several incandescent electric lamps. These are in metallic contact with a source of electricity on the ground. In the circuit on the ground is an apparatus for making and breaking contact rapidly. By varying the duration of the flashes of light in the balloon it is possible to signal according to the Morse or any other known code. Here I have a model signalling balloon in mid-air. I depress my signalling key, and the balloon appears like a globe of fire. By arying the duration of this globe of fire, by long or short depressions of my key, I can signal a sentence according to the Morse or any code. On the switchboard which contains the signalling key there is an arrangement by which the lights can be continuously switched on thus. The continuous illumination has its uses in war. It can be used as a preconcerted signal, or as a point light to concentrate troops at night to a given place.

The picture now on the screen represents the signallers of two friendly military forces shut in by high mountains. It shows how limited is the usefulness of ordinary visual signalling which depends upon some vantage point for altitude. It shows, I think, how valuable in such a case is the electric signalling balloon. I will ask whether this picture does not fairly represent the conditions realised sometimes in the South African campaign when failure of means of communication was the cause of disaster. Certain examples of the want of means of communication in the war emphasized in my mind the necessity of extreme mobility for the appliances of a signalling balloon so that the apparatus might be conveyed, if possible, by a few men. To meet this need I designed the emergency signalling balloon. Compared with an ordinary balloon transport, I have always described my ordinary electric signalling balloons as portable. Before you is a picture of a signalling balloon of 18 feet diameter taken at the Cork military tournament. This has a gas capacity of 3,000 cubic feet, and it requires 30 tubes of compressed hydrogen to fill it. But the emergency balloon is so portable that it can go wherever the signallers can go, and yet will supply the means of obtaining a considerable altitude for the signals. To accomplish this I have approached the impossible as far as I have dared, and in some parts of the apparatus strength and durability have had to be sacrificed to lightness. However, if a whole battalion could be saved by the use of an emergency balloon this sacrifice would be justified, even if the balloon could only be used for a few times. This, however, would not be the case, as the balloon could be used a number of times. To obtain lightness in the emergency balloon I employ goldbeaters' skin instead of varnished cambric, with the material of which only larger signalling balloons were made. Then the metal aluminium, the density of which is only 20·6, helps us to obtain portability, for we can make the ladder frame on which our lamps are suspended of this material. Mobility is also afforded by improvements in electric storage batteries, which are thereby rendered very portable. These two small batteries contain six cells in each, and I will just show you how brilliant a light it is possible to get with the two batteries, which can be carred one in each hand. Such a battery as this would supply power for intermittent signalling for weeks. In such cases, where batteries are not available, I should propose the use of a portable hand dynamo. From this table dynamo I can produce an electric light, and a little exaggeration of this would provide us with power. I reckon that the smallest possible size for an emergency electric signalling balloon to be useful, would be seven feet diameter. This would lift a light cable, and the lamps a few hundred feet, and only require gas cylinders 120 cubic feet capacity for its inflation. There would therfore be no difficulty about its transport. A better size giving more useful lifting power, would be eight feet diameter, I consider that the emergency signalling balloon might be even ten feet diameter, without the transport being impracticable in places inaccessible to waggons.

It has sometimes been urged that the signalling balloon is only of use in absolutely calm weather. The view upon the screen contradicts this statement. It illustrates the use of the electric signalling balloon in half a gale of wind, on the evening I carried out the experiments at the Stamford-bridge Grounds, in the presence of H.S.H. Prince Edward of Saxe Weimar and a number of military and naval experts of various nationalities. This I accomplished by the liberal use of guy ropes. Some of the Government trials of my signalling balloons have taken place in very unfavourable weather conditions, for instance, on the occasion of the trial of the balloon in connection with the signalling department at Aldershot, in January, 1885, there was a snowstorm and a mist. A party of signallers was stationed three miles from the camp, and in spite of the mist and thickly falling snow, the signals were read and answered. This was a remarkable test, because the balloon on its descent was found to be crystallised, and much of the light must have been obscured, first by the falling snow, and second, by the crystalline coating on the balloon.

There are some details of the system on the lecture table which may be of interest. Here is the ladder-shaped holder of lamps which is placed in the larger size signalling balloon. This is the lighter aluminium frame for use in the emergency balloon. This is the signalling key I first made with platinum rubbing contacts, and this the later form of key with removable carbon contacts for use with heavy currents. Here we have the arrangement for suspending the lamps outside the balloon, a plan I adopt in foggy weather. This is the special holder of lamps placed inside the great electric balloon of 100,000 cubic feet capacity which I made some years ago for the Crystal Palace Company.

The free balloon has its use in war, as well as the captive one. At the time of the siege of Paris, this was demonstrated most efficiently. At the time when the Parisians found themselves cut off from all ordinary means of communication; there were only a few balloons in Paris, but the successful escape of some aëronauts in them was encouraging enough to establish an aërial highway involving a more wholesale manufacture of balloons than has been accomplished before or since that period; the disused railway stations were converted into balloon manufactories and training schools for aëronauts. During four months 66 balloons left Paris, 54 being specially adapted for the administration of post and telegraph, 160 persons were carried over the Prussian lines, 3,000,000 letters reached their destination, 360 pigeons were taken up, of which only 57 came back. These, however, brought back 100,000 messages.

The utility of a free balloon in war would, however, be largely increased if it could be steered against a wind of considerable power. Aërial warfare in navigable balloons is the prophecy of the poet. Tennyson has written of "the nations' airy navies grappling in the central blue." But science as yet has not produced a navigable balloon capable of fulfilling this vision of fancy, and even if it had it is probable that an international convention would prohibit the discharge of explosives from aërial vessels, "The rain of ghastly dew," as being too barbarous even for modern warfare. Though I do not wish to speak in defence of such a system of warfare, yet I would ask whether torpedo warfare, which is generally accepted, is not equally uncivilised. But if never used as a floating battery, a balloon that could navigate the air against even a moderate breeze would be a great advantage to an army for scouting purposes. Briefly let me describe the principal attempts to produce a navigable balloon, and show you some illustrations of the various types. Giffard, in 1852, was the first to make a navigable balloon of elongated form in which the motive power was steam, a very light engine as boiler working a screw 12 feet in diameter as shown in the picture. He ascended in this balloon on September 12th, 1852, on a very windy day and did not attempt to struggle against the wind. In 1883 the brothers Tissandier constructed an elongated balloon, the screw of which was worked by an electric motor, and claimed that they held their own against a wind of three metres a second. In 1885 Captains Krebs and Renard experimented with their fish-shaped balloon "La France," in which the motive power was also electricity, and with this balloon they made five return journeys out of seven ascents, and combatted a wind force of from 3 to 3½ metres per second. In 1889 Count Zeppelin built his vast airship, composed of 17 separate balloons, held together by an aluminium framework. A snap-shot of this balloon in mid-air is shown you. In this the motive power was provided by two Daimler motors of 16 horse power working four small screws of 44 inches diameter. But this airship, probably for the very reason of the smallness of its screws, did not excel the performance of Captains Krebs and Renard in 1885. In 1901 M. Santos-Dumont made his famous voyage round the Eiffel Tower with his No. 6 navigable balloon, the screw of which was worked with a 20 horse-power petroleum engine. When we examine the wind forces overcome, in the Santos Dumont's experiments, we find they amounted to about 4½ to 5 metres per second, an advance of a metre and a-half per second on the experiments of Captains Krebs and Renard in 1885. But it must be remembered that the latter had only 9 horse-power, whereas the former had 20 horse-power.

With present knowledge, a balloon can be steered in calm weather, but the question how to navigate it in any wind is absolutely unsolved. This working model shows you the principle of a navigable balloon. In the calm air of this room, by means of its rudder and screw, we can navigate it where we will. To further the solution of the problem of a navigable balloon, capable of being useful in war, careful quantitative experiments will be more useful than any number of the more sensational journeys under the conditions of money prizes in which the scientific desiderata are not sufficiently taken into account. When I say this I do not belittle the work of such heroes of aërial navigation as M. Santos-Dumont. By his bravery and perseverance he has winged the petroleum motor, and shown possibilities for the future. But in the future the problem must be more seriously attacked than for the purposes of sport. The time has arrived for the endowment of aëronautical research. In conclusion, may I express the hope that before long the British nation will apply to aëronautics some of its engineering skill, and launch into the air a navigable balloon which will be able to overcome a sufficiently strong wind to add to the resources of our national defences.

DISCUSSION.

Mr. H. Middleton said Mr. Bruce had not referred to the fearful destruction which could be caused to vessels of the navy by a balloon dropping explosives down on the decks from above. Such an operation could be performed at night when the enemy could not see the balloon. Even supposing a balloon should not ordinarily be kept at a definite height above the ground, such a thing was possible over the sea by means of trailing ropes. It would also be of interest to know whether M. Santos-Dumont had any horizontal steering apparatus on his balloon except the rudder, which would only act when the balloon was in motion. M. Dumont had discovered what he (Mr. Middleton) pointed out a great many years ago, viz., that if the position of the axis of the balloon was changed, when driven against the air, the balloon would go up or down. In addition, such a balloon when pulled forward tended always to go upwards, the centre of resistance and the line of action of the propelling forces not being directly opposed to one another.

Mr. P. Spencer said that experiments had shown as a fact that, strength for strength, the skin used in the manufacture of balloons by the British Government and also by some private persons was 33⅓ per cent. lighter than the ordinary balloon fabric. The fact that a balloon made of such skin was exactly three times as expensive as a balloon made of fabric would prevent its general use; but there was no doubt that when absolutely the best article was required it was impossible to improve upon such a very light gas-tight animal membrane. It was quite possible that the question of ballooning would now make rapid progress. With the further interest aroused in the young Brazilian's experiments, and the fact that, as Colonel Templer had said to him the other day, "We must not be beaten in this matter," there was no doubt as years went on that further advances with propelled and navigable balloons in this country, not only by civilian aeronauts but by the military authorities, would be made.

General R. EARDLEY WILMOT read a letter which he wrote to the editor of the *Standard* in July, 1882, drawing attention to a letter from Mr. Coxwell, in which that gentleman advocated the use of balloons for observation purposes in warfare. He maintained in the letter that in Cabul in December, 1879, when the British forces were shut in within the walls of Sherpore, a stationary balloon would have been of the utmost value, enabling those besieged to watch every movement of the enemy, which, from the fact of the place being surrounded by successive high mountains they were unable to do. The unfortunate blunder in the Chardeh valley on the 11th December, could never have occurred, for a balloon suspended high in the air, would have shown every village to have been packed close with armed soldiers. He received a reply from Mr. Jacob Green, the celebrated professional aeronaut, corroborating his views with regard to the exceeding usefulness of balloons in war, and expressing the opinion that a navigable balloon would be of still greater assistance. He wrote the letter, because when he was in India in 1879, he reconnoitered with Sir William Lockhart, who subsequently became Commander-in-Chief in India, the country in which the unfortunate disaster occurred on the 11th December. From the top of a hill he saw with the binoculars thousands of the enemy coming over a pass not six miles away. On the matter being reported to Lord (then Sir Frederick) Roberts, he sent for the political officer, who, on being told the fact, said the men who had been seen were fruit sellers. The consequence was that the troops two days afterwards, under General Massey, lost several guns, the whole of the 9th Regiment was cut to pieces, and the Bengal Lancers lost 37 out of 60 men. If the army had then possessed a balloon such a thing could not have happened.

Mr. WALTER REID said that although the military authorities in former times might have neglected the subject of balloons, there was every indication that at present they were fully alive to their value, Mr. Bruce having given several illustrations of the great efficiency to which the authorities had attained in their construction. There was no doubt that the substance of which the balloons were composed, gold-beaters' skin, was one of the best articles, if not the best article, for retaining gas; at the same time it was extremely light. On the other hand, it was too expensive for ordinary civilian purposes. Ordinary balloons were undoubtedly too heavy, to a great extent because of the varnish used in impregnating the material in the endeavour to render it gas-tight, which it did not. The basis of nearly every varnish used in ballooning, at the present time, was linseed oil, which, after oxidation, was not impermeable to gas. As soon as linseed oil oxidised, it formed an elastic film which, however, was not the final product of oxidation. The reader of the paper had described how, on one occasion, he had actually seen a balloon catch fire by the heating of that further oxidation. It was a well-known fact that the heating of the oxidation of linseed oil, after it had dried, was quite sufficient to cause ignition. He had oxidised many thousands of tons of linseed oil, and knew the danger. The product of oxidation was a viscous, sticky substance, which was the cause not only of the balloon, when packed up and placed in a heap, sticking together, but of the fibre rotting away very rapidly. In the industry of oxidising linseed oil for linoleum, the fabric brought into contact with the linseed oil became absolutely rotten, being reduced to powder afterwards in the subsequent operations, the same action taking place in the woodwork of the buildings where the oil was oxidised. With a very great experience of such matters, he could state with perfect confidence that no linseed varnish would be absolutely satisfactory. Cellulose varnishes, which had not been largely used in ballooning, were now coming into use; but so far as he was aware, Count Zepperin was the only inventor who had used this material in his big balloon. Such varnishes had the advantage of being extremely permanent, not oxidising. If an impermeable varnish of cellulose was obtained, it would be possible to retain gas in a fabric which could be produced at a very much lower price than any form of goldbeater skin. Mr. Bruce had committed himself to the opinion, with regard to the use of balloons in warfare, that some international convention should prevent the dropping of torpedoes or explosives from a balloon. He totally disagreed with such an opinion, believing that any nation which had the means of destroying the human beings fighting against it would use them, no matter what the international convention might be. It was found in the Transvaal that the use of explosive bullets by the Boers, instead of being a rarity, was perfectly common, where the enemy had been reduced to such a condition that he had to use every means he could possibly find. In his opinion there would be aerial torpedoes in the future, the same as there were submarine torpedoes.

Mr. P. L. SENECAL regretted that the authorities connected with the South African war had not taken more advantage of the immense improvements made in the construction of balloons. He also deplored the lack of interest on the part of the general public in the subject. Balloons of large capacity made of goldbeaters' skin were not so strong as similar balloons made of silk, because the latter could be constructed with several thicknesses.

Major F. C. TROLLOPE said that, as he was left in charge of the balloon factory, at Aldershot, at the outbreak of the war, he was anxious to discover how the balloon corps had succeeded in South Africa. On questioning Sir George White, he was told that a balloon in charge of Captain Heath made an ascent from Ladysmith every morning during the siege, and as the Boers always fired at the balloon, everybody knew exactly where the enemy were. By discovering that the big guns had been shifted to other positions, the balloon corps rendered splendid service to the garrison. An exactly similar state of affairs was experienced by the balloon corps on the Tugela, the balloon, when it came home, being found to have several holes in it. At Paardeburg the balloon officer signalled that the troops were firing at the wrong mark, and directed the artillery to fire at the bottom of the river where the Boers were concealed, the result being the capture of Cronje and his army. The difficulty at present experienced was that the generals and officers in command did not know how to use the balloons, After ordering a balloon to ascend it had been impossible to find the general in order to communicate important messages from the balloon observation corps relative to the position of the enemy. He hoped that difficulty would be overcome in the future. In China, where the English balloon corps had a goldbeaters' skin balloon and the French one made of silk, it was arranged that a show should be given by the respective corps. The Englishmen purposely kept their balloon at a low altitude until they found the French balloon had reached the maximum height of 450 feet, and then let their balloon ascend to a height of 1,500 feet. The great difficulty in connecion with captive balloons was the holding of the gas, nd the man who discovered a good varnish would eceive everybody's thanks.

The CHAIRMAN said it fell to his lot to go through he whole of the siege of Sebastapol, and he thought ie could elucidate very easily the reason why the dea of using a balloon could never have been ntertained at that time. The weapon then used vas the old-fashioned Brown Bess, with a very loubtful accuracy at its extreme range of 100 yards. Vhere it was necessary to make a reconnaissance, iot only in that campaign, but in the Peninsular war lso, the officer obtained half a squadron of troops, lressed in the gayest possible uniform, which antered to within 200 or 300 yards of the enemy's ositions and made careful observations, knowing hat they were practically quite safe. But such condition of things was impossible in modern arfare, where the range of the rifle had been icreased tenfold, the English soldier now, when iaking a reconnaissance, being under the distasteful uty of crawling on his stomach as if he were alking deer. The balloon industry was at present nly in its infancy; and he, therefore, felt it his duty say that there was no indifference on the part of ie army towards ballooning, nor was any ridicule ist upon the possibility of men in the air being f material use in saving, perhaps, a whole division om annihilation. All thinking men must be firmly npressed with the absolute necessity of some mode of connaissance being carried out which would enable i army to obtain security in an unknown and unirveyed country. The efforts of the balloon party uld not, therefore, be too highly estimated, and the fact that thirty balloons were sent out to South Africa proved that they had not been overlooked. After a very long military experience, extending over 57 years, he could assure the audience that every thoughtful member of his profession would give every possible assistance to any gentleman who was more accustomed to scientific processes than soldiers were, in his endeavour to develop the question, and improve upon M. Santos Dumont's results. While wishing the young Brazilian every success it was not advisable that competitors should follow too closely in his footsteps, and take up the matter simply for sport. Investigations which would prove of real use to the industry were required. In conclusion, he moved a cordial vote of thanks to Mr. Bruce for his valuable contribution.

The resolution having been carried unanimously,

Mr. BRUCE, in reply, said that M. Santos-Dumont had to some extent, by inclination, regulated the vertical motion. It was one of the most important points connected with practical aeronautics to be able to regulate better the vertical motion, so that various currents in different direction which existed at varying altitudes might be reached. There was no reason why engineering skill should not be applied to the vertical motion; and he believed at least two inventors, Dr. Barton and Mr. Beddall, were at work on the subject, the latter having had some screws placed underneath his air-ship to raise or lower it into different currents. M. Dumont depended on the rudder for the horizontal movement, and obtained a vertical movement by inclination of the machine. He was exceedingly pleased to hear Mr. Reid's remarks. Linseed oil was almost useless for a balloon; a good varnish was the great thing needed. If a chemist would definitely take up the work and try and produce a suitable varnish he would confer an incalculable boon on balloonists, because they could not all afford expensive goldbeaters' skin balloons.

Miscellaneous.

TIN AND TIN MINING IN NEW SOUTH WALES.

The existence of tin in New South Wales was discovered in 1851, but it was not until over twenty years later that mining operations were commenced. In 1872, according to Professor David, of Sydney University, tinstone was accidentally discovered while searching for gemstones near Inverell, in the northern part of the State. Mixed with a number of sapphires and other gems in the gravels of the creeks was a heavy black mineral, in water-worn grains, which, on assay, proved to be oxide of tin. The discovery becoming known, a Sydney company took up some ground in the vicinity, and then commenced a rush to what are now known as the New England tinfields. The stream tin, as the black mineral is called, had long been familiar, under the name of "black sand," to alluvial gold miners in the district, where its weight, rendering it difficult of removal from the sluice-boxes, had caused it to be regarded as worse than a nuisance. In some places, the stockmen, ignorant of the real character of the sand, used it for cleaning their bits. Native tin has been found in the State, but, as in other parts of the world, it is of rare occurrence. The same may be said of stannite, or tin pyrites, although it is plentiful, with galena, zincblende, and arsenical pyrites, in the Borah Creek Silver Lode, near Inverell. The common ore of tin is the oxide, otherwise known as cassiterite or tinstone, found in New South Wales in several forms, and of various colours. At Vegetable Creek, the leading tinfield in the State, between 1872 and 1885, 15,000 tons of cassiterite are said to have been extracted from a shallow alluvial deposit, within a distance of a little over five miles from its source downwards. The total area of ground worked was about 150 acres, which produced 15,000 tons of stream tin, or at the average rate of 100 tons per acre, or half a hundredweight of cassiterite per cubic yard, allowing the mean depth of the washdirt to be two feet six inches. The depth of stripping (over-lying soil) varied from six inches to nine feet. At Catarrh Creek about 1,000 tons of stream tin were obtained from the shallow alluvials within a distance of about one mile. The width of the deposit varied from three to seven chains, and the depth of sinking to the granite bed rock was from ten to fourteen feet. The Vegetable Creek workings are situated in what, during early Tertiary times, formed the main drainage channel of this part of the State. In portions of its course there were two distinct flows of lava, an older and a newer, each covering a bed of stanniferous washdirt. Up to 1886 the produce of these latter was 6,000 tons of stream tin in a distance of 2 miles 30 chains. At one place, an area of 5½ acres of gravel, having an average thickness of three feet, yielded 2,000 tons of tin-ore. In the far western portion of the State, at Euriowie and Poolamacca, about fifty miles to the north of Broken Hill, tin ore occurs under conditions differing materially from those of the other New South Wales tinfields, the ore bearing a marked resemblance to that from the Hornsey Peak mines of Dakota, in the United States, and to such an extent that specimens from the two places cannot be readily distinguished from each other. A considerable area of ground was pegged out for mining purposes when these deposits were first discovered, but probably not more than one hundred tons of dressed ore were despatched from the field before it was abandoned. The scarcity of water for the necessary concentration processes, and the distance (several hundred miles) which separates the district, which is rich in minerals, from the seaboard, are the chief reasons which led to the cessation of mining operations, which are certain to be resumed when conditions are more favourable. It is, however, as pointed out by Mr. E. F. Pittman, in his work on "The Mineral Resources of New South Wales," in the northern portion of the State that the principal stanniferous deposits occur. From near Tamworth, tin-bearing rocks extend northwards, with some intermission, up to the Queensland border. The mean width of this area is about 30 miles, and within it are the leading New South Wales tinfields. The largest export of tin raised in the State was 9,125 tons, value £824,552, in 1883; and the greatest value £833,461 (for 8,670 tons), in the previous year. The quantity exported in 1900 was 916 tons 7 cwt., value £120,932, making the total quantity exported since the opening of the New South Wales tinfields, in 1872, 135,078 tons, value £10,849,238. This does not include the produce of other States.

PRODUCTION OF CORK IN THE WORLD.

A late number of the French *Journal Officiel*, contains the following particulars of the production of cork in the world, which are quoted from the *Board of Trade Journal*. The production, estimated at 1,000 metric tons (metric ton = 2,204 lbs. avoirdupois) is limited to those regions whose shores are washed by the Mediterranean and the Atlantic, extending from Morocco up to 45 degrees North Latitude, nearly to Bordeaux. The only producing countries, therefore, are Portugal, Spain, France, Italy, and North Africa (Tunis, Algeria, and Morocco).

It is impossible to determine, even approximately, the total extent of the forests of cork trees, owing to the lack of any precise information. Speaking generally, however, it is known that the forests in which the cork tree is found in more or less profusion, cover an area of about 600,000 hectares in Portugal (hectare = 2·47 acres), 300,000 in Spain, 80,000 in Italy, and France (with her North African possessions) 661,000 hectares, of which 426,000 are in Algeria, and 82,000 in Tunis. But it may be said that the area of French forests, including those in North Africa, really producing cork, is more than one-half of the total extent of cork forests. These forests are composed mainly of cork trees intermixed with pines and evergreen oaks; in the Eastern Kroumirie, however, magnificent forests of cork trees are to be found in their virgin state, which will in the future give a large production of cork.

The demand for cork increases from day to day, and there is no doubt that when the production is increased it will find a ready market, especially the better qualities. It is said that France, the United Kingdom, Germany, Russia, and the United States absorb 85 per cent. of the total consumption of cork.

Germany, Russia, and the United States of America impose prohibitive duties on cork manufactures, and, in order to assist the home industry, admit the raw material almost free.* The United Kingdom alone imposes no Customs duty on either, but her consumption of the manufactured article is provided for by French and Spanish manufacture, and by Portugal, from which country the United Kingdom imported, in 1900, manufactured cork to the amount of 5,916,017 lbs. Spain exports principally the finished product. Catalonia supplies champagne corks of superior quality, which are sold at from £6 2s. to £6 13s. per thousand.

The *Journal Officiel* goes on to say that France and her African colonies have every interest in increasing their production of cork, and taking pre-eminence in the markets of the world, the more so as Portuguese cork, which grows so rapidly owing to the humidity of the climate, is of inferior quality to that of the Mediterranean littoral. The bad name which African cork has borne for a long time is now a thing of the past, the complete collection of samples exhibited at Paris last year, having entirely removed the impression.

In Tunis, where there yet remain several large forests to be taken into account, the production of cork was 9,930 quintals in 1900, and 11,882 quintals in 1901. The cork, which was bought by French and Algerian merchants, and taken away immediately for manufacturing purposes, was sold at an average price of 28 francs per quintal in 1900, and 32·84 francs per quintal in 1901. Tunisian cork is, generally speaking, of a good quality, and certain parts of the Kroumirie are said to furnish a very hard cork with a fine grain, and for that reason it is much sought after by the trade. There is, however, a difference in the sale price of Tunisian cork compared with the price obtained by the Algerian product, but this is due to the fact that in Tunis, only cork of the first growth, which has a very thick crust, is sold, and consequently it loses much of its value in being scraped. In the near future, Tunis will collect cork of the second growth, the quality of which, it is said, will certainly equal that of Algeria.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 26.—"Recent Inventions in Weaving Machinery." By PROF. ROBERTS BEAUMONT, M.I.Mech.E. SIR OWEN ROBERTS, D.C.L., will preside.

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS. LORD RAYLEIGH, D.C.L., LL.D., F.R.S., will preside.

MARCH 12.—"The Utility of Alkaline Phosphatic Manures." By JOHN HUGHES, F.I.C. PROFESSOR HENRY E. ARMSTRONG, L.L.D., F.R.S. will preside.

MARCH 19.—"Electric Traction. London's Tubes, Trams and Trains." By J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E.

⁂ Prof. Thompson's paper previously announced for this date will be read at a meeting after Easter.

Dates to be hereafter announced:—

"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

"Servia as a Field for Railway, Mining, and Commercial Enterprise." By EVERARD R. CALTHROP, M.Inst.C.E., M.I.Mech.E.

"The Rural Schools of France." By CLOUDESLEY BRERETON.

"Recent Work on the Photography of Colour." By SIR WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S.

"Remains of the Greek Occupation of Sicily." By DR. J. LEON WILLIAMS.

"Photographic Surveying." By. J. BRIDGES LEE, M.A.

"Ceuta and Gibraltar." By MAJOR-GEN. JOHN F. CREASE, C.B.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 27.—"The Industrial Development of India." By NILKANTH B. WAGLÉ, B.A. The EARL of HARDWICKE will preside.

MARCH 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By THOMAS WILLIAM HOLDERNESS, C.S.I., Secretary, Revenue Department, India Office. SIR ANTONY PATRICK MACDONNELL, G.C.S.I., will preside.

APRIL 17.—"Recent Developments in Punjab Irrigation." By SIDNEY PRESTON, A.M.Inst.C.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab.

The reading of Sir Thomas Holdich's paper on "Our Commercial Relations with Alghanistan," previously announced for April 17, is postponed.

MAY 1.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G.

APRIL 22.—"British Commercial Prospects in the Far East." By BYRON BRENAN, C.M.G., late H.M. Consul-General at Shanghai.

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* Cork (raw) enters Germany and the United States free, nd in Russia there is a duty on its equivalent to about 1s. er cwt.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock :—

MARCH 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY. WALTER CRANE, A.R.W.S., will preside.

APRIL 8. 8 p.m.—"Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington. H. H. STATHAM, F.R.I.B.A. will preside.

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

CYRIL DAVENPORT, F.S.A., "History of Personal Jewellery from Prehistoric Times." Three Lectures.

LECTURE III.—FEBRUARY 24—BROOCHES and their development from pins—The Celtic pen-annular brooches, Merovingian circular and rectangular brooches and their derivatives—Buckles—Roman and Greek fibulæ—Scandinavian and Anglo-Saxon brooches, with cut garnets and niello work, and the heavy boars-head brooches from Gotland.—PENDANTS as separate ornaments—The symbolical ornamentation of jewellery, swastika and triskele—Precious stones—Processes—Modern work—Summary.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.
March 3, 10, 17.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures.
April 14, 21, 28, May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Cyril Davenport, "History of Personal Jewellery from Pre-historic Times." (Lecture III.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Hon. J. H. Turner, "British Columbia."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Rowland Berkeley, "Electric Railways and Street Compensations."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn Hall, Holborn, E.C., 5½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Barry Parker, "Designing a Comfortable House."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. Ramsay, "Inert Gases of the Atmosphere."

TUESDAY, FEB. 25...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. N. Shaw, "The Temperature of the Atmosphere: Its Changes and their Causes." (Lecture I.)

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W. Discussion on Messrs. W. M. Mordey and Bernard M. Jenkin's papers on "Electrical Traction on Railways."

Photographic, 66, Russell-square, W.C., 8 p.m.

WEDNESDAY, FEB. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Prof. Roberts Beaumont, "Recent Inventions in Weaving Machinery."

Geological, Burlington-house, W., 8 p.m. 1. Mr. Edwin A. Walford, "Some Gaps in the Lias." 2. Mr. A. Strahan, "The Origin of the River-System of South Wales and its Connection with that of the Severn and Thames."

United Service Institution, Whitehall, S.W., 3 p.m. Admiral Sir J. O. Hopkins, "Is a Second-class or Smaller Battle Ship Desirable?"

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

THURSDAY, FEB. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Nilkanth B. Waglé, "The Industrial Development of India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Wm. Carl Armbruster, "Schubert, Schumann, and Franz."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Henry Craik, "Scotland's Contributions to the Empire." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Major-General C. E. Webber, "Electric Shock and Legislation thereon." 2. Mr. F. B. Aspinall, "Electric Shocks." 3. Mr. A. P. Trotter, "Electric Shocks at 500 volts."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. T. C. Porter, "The Austrian Tyrol."

FRIDAY, FEB. 28...United Service Institution, Whitehall-yard, 3 p.m. Staff-Sergeant H. Stapleton, "Amalgamation of Bearer Company and Field Hospital as a Military Unit."

Royal Institution, Albemarle-street W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Henry A. Miers, "Gold Mining in Klondyke."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. A. M. Arter, "Indicating High-speed Steam-Engines."

Architectural Assoc., 56, Great Marlborough-street, W., 7½ p.m. Mr. T. H. Russell, "Dartmoor Granite."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MARCH 1...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Some Electrical Developments." (Lecture III.)

CORRECTION: p. 222, col. 2, l. 37, *for* Captain Baker *read* Mr. Thomas.

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FRIDAY, FEBRUARY 28, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, March 3, 8 p.m. (Cantor Lecture.) J. D. Geddes, "Photography as Applied to Illustration and Printing." (Lecture I.)

Tuesday, March 4, 8 p.m. (Applied Art Section.) Gerald C. Horsley, "Structural Colour Decoration of the Interior of Public Buildings."

Wednesday, March 5, 8 p.m. (Ordinary Meeting.) E. Price Edwards, "Sound Signals."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 24th inst., Mr. Cyril Davenport delivered the third and last lecture of his course on "The History of Personal Jewellery from Prehistoric Times."

A vote of thanks to the Lecturer was passed on the motion of the Chairman (Sir George Birdwood, K.C.I.E., C.S.I.).

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, February 27, 1902; The Earl of Hardwicke in the chair.

The paper read was "The Industrial Development of India," by Nilkanth B. Wagle, B.A.

The paper will be published in a future number of the *Journal.*

Proceedings of the Society.

COLONIAL SECTION.

Tuesday, February 18, 1902; The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., LL.D., in the chair.

The paper read was—

THE FRENCH CANADIANS AND THEIR RELATIONS TO THE CROWN.

By W. T. R. Preston

(Commissioner of Emigration for the Dominion of Canada).

New France was practically founded as a colony in 1608, one year after the planting of the first permanent English settlement of Virginia in North America. This step was dictated by the new order of things arising in Europe, where statesmanship recognised that the prestige and power of European nations would largely depend upon their colonial possessions, and that colonisation and commerce went hand in hand. The Catholic Church in France, with its splendid missionary zeal, at once seconded in the most signal manner the efforts of the State. It is mere justice to say also, that the Church was the mainstay in promoting the moral and material development of the new colony, as well as in furthering the political designs of the French Crown for obtaining the mastery of the western continent.

Meanwhile, along the Atlantic coast to the south, the New England colonies grew in number, population, and wealth. The circumstances attending the foundation of these colonies, generally in despite of the British Government, and the democratic character of their institutions, account for their sturdy self-reliance and their semi-independence of the motherland. In their political relations with one another there was an absence of sympathy or co-operation. Each colony was intent on its own development, and it was no easy matter in times of common danger to secure cohesion and united action. In Canada, on the other hand, there was centralisation of power, and a settled and far-reaching policy, steadily pursued by the French Crown, to prevent the expansion westwards of the English settlements, and an avowed determination to prevent them extending beyond the Atlantic coast line. By right of discovery and occupation, by alliances with Indian tribes, by the construction of fortified posts, the immediate *hinterland* of these settlements beyond the Alleghanies, including the line of the Mississippi river, was closed to the British, and the control of the west ensured to France. For this work (in addition to intermittent aid from the King) the Governor of New France had at his command the resources of the entire colony, where the whole of the population was in the nature of a trained army settled on the soil under semi-feudal conditions, owning unquestioned obedience to the Crown. France, however, grasped too much in attempting thus to win simultaneously a controlling position in Europe, and an Empire in the New World. Under his successor the exhaustion which followed Louis XIV.'s ambitious efforts in Europe ruined the prospects of a Colonial Empire which had been so masterfully conceived. By the fortune of war, Canada was finally ceded to England in 1763, and this country then emerged as victor from the tremendous duel for the mastery of a continent. But it was a success fated to have strange and unexpected results.

By the year 1775, an impracticable monarch with impossible views of personal government, and a subservient and incompetent ministry, had succeeded in exasperating a high-spirited and independent people beyond the limits of patient endurance. The old pressure from the feared and active power of France on their borders had been removed for ever; the strain proved too great, and the chain of allegiance to England was snapped. And here, by the irony of destiny, the Canadians proved England's salvation. These new subjects rejected the proposals of the revolted colonies to join them, and by their action the northern half of the continent was preserved to the British Crown.

And yet the story of the French Canadians and their relations to the Crown is probably one with which the average educated man in the United Kingdom is least familiar, charged as it is with incidents of fascinating interest, historical and constitutional. In this country the only knowledge of the French in Canada, I believe, will be found limited to the incarnation of the race, in General Montcalm, in the story of those two heroes of our school days, Wolfe and Montcalm, and the genius, chivalry and indomitable courage of both in the struggle which closed in that dramatic and short, but none the less decisive of world battles, on the Plains of Abraham. Few Englishmen have followed closely the fortunes of the French race in Canada from that day to this, and are aware of the splendid work they have done in the cause of political freedom, and for the development, material and intellectual, of Canada in friendly rivalry with their fellow subjects under the British Crown. Now England suddenly awakes with startled surprise to find a French Canadian the acknowledged and applauded leader of both races in Canada; a man who, by the measure of his achievements as a practical statesman, his high character and well-balanced sympathetic insight into the problems of the Empire, is a finished product of the moulding forces of free British institutions, and, I doubt not, one destined to take a distinguished part in linking together the colonies and the motherland in closer harmony and union.

Students of constitutional history have long since learnt that differences of opinion exist as to the concessions alleged to have been made to the French population when Canada passed under British rule. The conclusion, however, seems fair that, under the Capitulations of Quebec and Montreal, by which Canada was surrendered to the British, by the Treaty of Paris, and the Proclamation of George III., the then French population of Canada were confirmed in all their rights as British subjects, of person, property and religion, and that they secured guarantees in practice, if not in theory, as to the use of the French language, the retention of the "Laws of Canada,"—*i.e.*, the Civil Code of France—while to the Catholic Church was left its right to tithes together, inferentially with other powers of government enjoyed by the Church incident to its special position under the French *régime*. Doubts as to the extent of these concessions, and the validity of the claims that have been made by the Church on behalf of the then population of Canada, both in respect to Church government and to other phases which have entered into the public discussions, have not been altogether set at rest. It has, however, been pretty generally conceded that the exercise of the rights alleged to be admitted to the Church and the people were rather strengthened than otherwise, in the first ten years, by a policy of general acquiescence in things as they were. Indeed, this is clear from the attitude of the early English governors. Both General Murray and his successor, Sir Guy Carleton—afterwards Lord Dorchester—were very sympathetically disposed to the "new subjects," and held them in high esteem for their many solid virtues and their tractable disposition, which differed greatly from the general turbulence characteristic of the incoming British settlers. It was mainly owing to the enthusiasm of the latter for the French Canadian population that the Quebec Act of 1774 was passed. This Act settled the question, whether the French Canadians were to be swallowed up by their English fellow-countrymen, or, by retaining their language and individuality, to develop side by side with them.

In 1763, when England's sovereignty over Canada was confirmed by treaty, the French population was estimated to number about 50,000 souls. The English population was probably less than one-fifth of that figure. A very large number of the French officers and of the nobility, including the official classes, who had taken up their residence in Canada, elected to return to France, leaving behind the *habitant* or peasant class in the country. The educated classes were thus greatly reduced and were mainly represented by the clergy. The people from the beginning acquiesced cheerfully in British rule, and this, no doubt, was largely caused by the considerate and liberal treatment which they believed had been extended to them under the capitulations, and in the subsequent assurances from those in authority.

It should not be forgotten, in the consideration of the French Canadian question, that when the British took possession, the clergy in Canada occupied a position not inferior to that which they enjoyed as a class in France under the Bourbons. On the sovereign councils for the government of Canada, appointed from time to time by the Crown, there were always representatives of the Church. Nothing of importance, as affecting the religious and civil government of the people or their material welfare, was decided without the concurrence of the Church. The position of the Bishop of Quebec, who, from the outset, occupied, by right, a seat on the council with the Governor, the Intendant was added later, was thus unique in the Government of the country. He was acknowledged as the principal adviser by the Governor, and was recognised by the people as the one most closely allied to the Government in the administration of the affairs of the colony. To him was paid little less honour than was shewn to the representative of his Most Christian Majesty. His authority was, therefore, unquestioned, his power recognised, and his social status assured.

The assumption of power by England in Canada was followed by fifteen years of military rule. This, perhaps, can hardly be said to have been consistent with British ideas of liberty, and it was certainly at variance with the promises given to the people that they should have the representative institutions obtaining in the English colonies as soon as the affairs of the country could be brought into order. English settlers had flocked into Canada on these assurances, and were not slow to ventilate their grievances. In 1774 the Quebec Act, already referred to, was passed, which expressly restored the French Civil Law, and established the Roman Catholic religion in so far as Catholics were concerned. The Government, however, was placed wholly in the hands of the governor and a council. The Act was not ungraciously received, even by the English community, considering the storm then brewing in the New England colonies, which burst in the following year, when, as I have already mentioned, the French Canadians gave practical proofs of their loyalty to England, very largely, it must be acknowledged, under the influence of their clergy. At the attack on Quebec a purely French Canadian brigade, led by French Canadian officers, repulsed and killed the American General Montgomery.

Later on, during the War of Independence, when France declared war against England, and assisted the revolted colonies in America in the struggle, there was every inducement for the new subjects to renounce their allegiance, but they never wavered in spite of the most earnest solicitations from their own countrymen.

When, however, the War of Independence was over, and the treaty of peace had been signed between the revolted colonies and Great Britain, Canadians found that their interests had been sacrificed in the most shameful manner by British diplomacy, in that an enormous area of country, now comprising the States of the Union—Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota, and containing at the present time a population of 15,000,000—had been wantonly and needlessly given away to the United States. This territory, covering not less than 280,000 square miles, was contemptuously described in the treaty negotiations by the British representatives as the "back lands of Canada, a country worth nothing, and of no importance." So that Canada, instead of being left as it was ceded to England by France, found itself apparently little more than a narrow strip of fertile land bordering upon the River St. Lawrence and the Great Lakes.

The effect of the American Revolution, followed by the recognition of the Republic by Great Britain, caused thousands of loyalist refugees to emigrate to Canada. Soon the clamour for English law and popular Assemblies became irresistible, and in this demand for self-government, the English settlers were warmly supported by the leaders of the French Canadians. On the report of Lord Dorchester, the country was separated in two provinces, each to have the form of constitution best suited to the wants of the inhabitants. With the support of the younger Pitt, the Constitutional Act of 1791, by which a form of representative government was given to Canada, was carried in the Imperial Parliament. Under this the people had conferred upon them the privilege of electing representatives to a so-called House of Assembly. They had, however, only the form without the authority or power of Government. By this measure the door was opened for a wider and more effective field for agitation, with prospects of much more dangerous conflict between the French population and the Government. The governing body, of course, was English. The Governor-General was surrounded by English advisers, nominees of the Crown, drawn mainly from the Legislative Council, the members of which were appointed for life. The English population of what are now known as the Eastern Townships of Quebec alleged that they feared French aggression and French rule. There was little disposition by them to allow the French population to have anything to say in government, although they were in the majority. The Englishman, with the born instinct of his race, wanted to rule, whether he was in the majority or otherwise. But a Parliament had been given to the French Canadians, and the events which followed the privileges granted by the Act of 1791 to the early thirties of the 19th century are a record of a ceaseless struggle for responsible government suited to free men, and approximating to the system which already had been adopted in the United Kingdom, and also enjoyed in the neighbouring Republic. They were the mutterings of the storm which was to make, later on, sad havoc of the intolerable pretensions of a factious minority.

But I am anticipating. In looking back, it is not difficult to explain the indisposition of the Imperial Government to grant at that time wider powers of government to Canada. Firstly and mainly, because England herself was new to, and had scarcely grown abreast of, that measure of responsible government for which the colony was looking. Then, also, the period was one of storm and stress, and of uncertainty. Great Britain was engaged in a death struggle with France, which increased in intensity during the next twenty years. Let it not be forgotten also, that throughout this period the United States was always the secret, and, on occasions, the active ally of France. Thus, in 1812, amid England's greatest preoccupations, and struggle in the cause of European freedom, the United States, on the flimsiest of pretexts, forced on the war of 1812-15 by a threefold invasion of Canada. Once again French Canadians were loyal and true to England, and rallied spontaneously and without hesitation in defence of that part of Canada which was in their keeping.

To return to the constitutional struggle which grew out of the Act of 1791. That struggle, though temporarily interrupted, gathered force, as may be expected after the sacrifices made by the population of Canada during the war.

The French Canadians in this respect did not stand alone. There was a not inconsiderable section of the English Canadians, among which were men of prominence, who supported Papineau, the famous Canadian tribune, and those with him in their agitation for reform, and who clamoured as loudly as the latter, not only for the form, but the actual authority of responsible government. Although many French Canadians, through their social position, and owing to recognition by the governing body, gave their sympathies to the ruling class, Papineau succeeded in carrying the great mass of the French population with him. It is only fair to Papineau's memory to say that from the beginning he called upon them to demand their rights of legislative power by constitutional means only. In this, however, he was outmanœuvred by the section of the agitators led by an Englishman, Dr. Wolfred Nelson, of Montreal. While events had thus hurried on to that conclusion in Lower Canada, public affairs took a somewhat similar shape in the province of Upper Canada. There, for many years, the governing body had used all the influence and all the power given under the authority of the Crown, to advance its own interests, in direct opposition to the wishes of a very large majority of the people. In

Upper Canada, as in Lower Canada, the form of popular government had been granted, without either the power or the authority. Thus it was that in the early part of the reign of the late Queen both these provinces broke out into rebellion, not by any means against the Crown, but against the governing bodies representative of the Crown.

The people, French and English, of both provinces, wanted responsible government. The agitation in each province was a separate and distinct movement, each independent of the other; but the same conflict, under different conditions, existed in both provinces. In each province were to be found eloquent and earnest leaders, who sought consistently to obtain their rights by constitutional methods; until finally a minority of extremists resorted to armed force.

After the suppression of the rebellion in Upper and Lower Canada, came the inquiry by the Imperial Government into the causes of the troubles. And for this purpose Lord Durham was sent to Canada in 1840. His report is one of those great and luminous State papers which are for all time, and its reissue by a London publisher within the last few weeks, after being many years out of print, will be of interest to all students of the evolution of the constitutional government in Canada.

The rebellion found its partial justification in a recommendation which Lord Durham made, the result of which was that the two provinces were united, and a form of popular responsible government was provided. In his masterly report, it may be observed, Lord Durham expressed his fear that Canada could never be governed until it was ruled by a majority of Englishmen. This is probably the only particular in which the future has failed to justify the predictions that are to be found on every page of that statesmanlike document. English statesmen learned very soon afterwards that, by their giving a system of local government to the French population, they secured in the colony a contented and happy people, who, from that time to the present, have never shown the slightest disposition to throw off British supremacy.

It will not be possible to follow in detail the various aspects of public life that have been presented in Canada since the union of these provinces. The present object is not so much to give a summary of the political history of Canada, as to point out wherein the French Canadian has not been wanting in those attributes and characteristics which tend to make a great nation, and which ought to place him in a position similar to the English-speaking Canadians, whose position seems more fully recognised in this country. In the contest in the Dominion for commercial or political supremacy—where neither the commercial nor the political currents are of a sluggish character—the French Canadians are, at the beginning of the 20th century, upon an equal footing with those other nationalities who have found a home within his Majesty's dominions on the North American Continent.

The French Canadian, as he is to-day, is not following in the lines of his restless countrymen in France. He is not the Frenchman of the Republic; he is not the Frenchman of the Empire; he is not the Frenchman of the Revolution, but he is to a great extent the Frenchman, in his traditions, of the 17th century. Paradoxical though it may seem, he has an affection for the tricolor, which is purely sentimental; has no sympathy with the events in France which preceded the tragic death of Louis XVI.; and reveres the memory of the dynasty which established his ancestors on the shores of a "Promised Land," where they have been enabled to work out a larger destiny.

In point of education, in point of aspiration, in point of progress, he remains the Frenchman, but with a strong dash of the Anglo-Saxon of the 20th century. He values the rights which he believes were given to his forefathers at the time of the cession, as to his religion, as to his language, and as to the French civil law. It is quite true that he glories in his own language, and he loves to talk about the splendid traditions of the race from whom he has sprung; but his thoughts run in a channel not likely to weaken his ardent admiration for British institutions.

The test of a progressive race is generally held to turn upon the attitude maintained by it towards education, and by the sacrifices which it is ready to make in that direction. Take then the question of education in Quebec. The province has a public school system more satisfactory, I venture to say, to any unprejudiced observer than the educational system for the masses in England. In respect to primary education, the statistics prove an average annual attendance of 70 per cent. of the number of children on the registers; while the Province of Ontario, in which it is natural to take exceptional pride, has an average attendance of about 52 per cent.

Are the people willing to contribute for their educational system? The answer to this inquiry is found in the fact that for public school purposes in the Province of Quebec, the people pay 89 per cent., by rates and taxes, of the entire expenditure; while the people in England and Wales, by rates, only contribute 35 per cent. of the entire expenditure, or, by rates and voluntary subscriptions together, 44 per cent. From this it will be seen that the French Canadian, who is not popularly regarded in England as progressive, actually contributes, out of his own pocket, a percentage twice as great for the purposes of education in comparison to the total expenditure for that purpose, as do the people in England. While it is true that the expenses *per capita* in the Province of Quebec are less than in the other provinces, or in Great Britain, as a set-off to this it must be remembered that the vast majority of the teachers in the public schools there are of the Order of the Christian Brothers of the Catholic Church, whose salaries are very small. At the same time, it is also only fair to say that they cannot teach unless they have the necessary qualification exacted by the Council of Public Instruction of the province.

Are the French in Canada endeavouring to make of themselves exclusively a French community? In answer to this, I say emphatically, they are not. Previously to the confederation of the provinces, there possibly was not as strong a disposition to embrace all the advantages afforded by English associations as now. Thirty years ago there were French Members of Parliament, at Ottawa, who could not speak English. I doubt if there is one member of the present Dominion Parliament from the Province of Quebec who is not as conversant with the English language as with the French. The French Canadians have recognised the fact that North America is an English-speaking continent. They have the same aspirations, and the same ambitions for themselves and their children that we experience. Many years ago they recognised that in the race for commercial, social, or political supremacy or preferment, upon the American Continent, where English is the language of eighty millions, they must become as conversant with the predominant language and methods as with their own.

Are they ambitious to undertake the task of Government under the British ægis? A study of the House of Commons at Ottawa reveals a presence of a larger proportion of men of pronounced parliamentary ability, and eloquent orators, hailing from Quebec, than from any one of the English provinces. In this connection, it will not be out of place to give as another reason that they are not exclusive, or that they are not simply looking for the advancement of their own race, and that neither as Frenchmen nor as Catholics are they intolerant, by the statement that at this time, out of a membership of sixty-five from the Province of Quebec in the House of Commons, no less than fourteen are English members, while the Province of Ontario, with ninety-one members, and a not inconsiderable French population in several constituencies, only elects one French Canadian to the Federal Parliament.

In regard to the charge of religious intolerance, statistics can be given to prove that from Confederation to the present day, there have always been double, if not a greater proportion, of English-speaking Protestant members from French Catholic Quebec in the Federal Parliament than either French or Catholic representatives from the English Province of Ontario, although there is both a very large Catholic, and a considerable proportion of French Canadians in this large English-speaking province. As a result of this spirit, it was possible for Sir Henri Joly de Lothiniere, himself a Protestant, and descended from an ancient and distinguished Huguenot family, to be for many years the chosen leader of his political party, representing an entirely French and Catholic constituency, and subsequently to become Premier of the province.

It might also be said that at no time has there been any general feeling or opinion manifested among the French population in favour of annexation to the United States. It is true that fifty years ago a so-called annexation manifesto was prepared in Montreal, but the signatures were almost entirely those of the English population. Many of them, however, afterwards attained distinction in public life in Canada, some even becoming recipients of high honours at the hands of her late Majesty, Queen Victoria.

No paper on French Canada would be complete without a reference to the Catholic Church in Quebec. The Church holds a stronger position in Canada possibly than in any other country. To appreciate this fact, it is necessary to understand the highly-centralised character of its organisation. This policy dates from the earliest times, and was due to the conditions of the country and to the personal views of that great ecclesiastic and founder of the Church in Canada, Bishop

Laval. The scattered settlements made removable *curés* in the parishes a matter of necessity; the *curé* was thus placed in the position of a missionary, to come and go at the order of his Superior. This system was not without its disciplinary advantages, but it added greatly to the power of the Church. The position of the Church in the government of the country gave it a prestige which the clergy were not slow to impress upon their parishioners; but it must be said that the Church has been the best of friends and guides to the population of French Canada at all critical times, and has consistently thrown its influence on the side of authority, with rarely misplaced confidence.

It is equally true that the Roman Catholic clergy have always been in the van in all moral movements, and equally prominent in their advocacy of large educational facilities, bearing more than their share of the responsibility in this connection, by furnishing able teachers and professors in schools and universities, at merely nominal salaries.

Reference and objection have often been made to the influence exercised by the clergy as political advisers to their parishioners. In this attitude they were never altogether discouraged by the political leaders in Canada. Their advice, in 1775, to reject the proposals of the American revolutionists was most far-sighted. Again, in the war of 1812–15 the whole body of clergy, as we have seen, was actively engaged in supporting the British cause. In the rebellion of 1837 the authorities only turned to the clergy with a view to strengthen the cause of the governing class, and to weaken the hold that Papineau had with the populace. The wisdom of the course adopted by the authorities in this respect cannot be questioned, as had the clergy not exercised their influence to restrain the vast majority who were following the leaders in demanding constitutional rights, and were willing to follow the extremists into rebellion, consequences much more serious might have ensued.

Upon other occasions political leaders have thought it wise to secure the co-operation of the Catholic clergy in matters of grave import. In the first Riel Rebellion—the Red River Rebellion of 1870—the authorities brought the Bishop of St. Boniface from Rome, with the view to quieting the disturbing elements in Manitoba. Other occasions on which political leaders have thought it wise, as it undoubtedly was, to take a similar course need not be enumerated. It was not, therefore, unnatural that the clergy should, in course of time, reach the conclusion that they had as much right to take part in political discussions as in the more limited sphere of their spiritual calling. Upon this question they did not stand alone, as in the neighbouring province upon other occasions over-zealous Protestant clergymen forced themselves upon platforms, more generally, however, in order to denounce Roman Catholicism, or to assume for personal motives, the rôle of defenders of Protestantism than anything else. Thus, as it happened, it was easier to allow the door to be opened for clerical influence upon one question or another, than to decide when the door should be closed. There were to be found in Canada at that time, politicians who encouraged the clergy in the Province of Quebec in acts which finally culminated in the belief by many of them that they had a divine right to denounce with vehemence the pretensions of political candidates to popular support, unless these candidates were personally and politically suitable to them. This aspect of the suppression or of improperly influencing public opinion in French Canada presented serious views. Finally, however, the hot heads among the Protestant population or clergy, who would have taken strong ground upon this question, were restrained, and it was left for the Catholic leaders and the Catholic clergy to solve this problem themselves. This crisis in the conflict between what might be termed the Liberal and Ultramontane parties in Quebec was reached in 1896. The crisis grew out of the suppression of certain rights which the Catholics believed they possessed in Manitoba, in respect to Separate Schools of their own. The Act of the Legislative Assembly of this province abolishing Separate Schools had been declared *ultra vires* by the Imperial Privy Council. But the Judicial Committee had also expressed the opinion that it was within the power of the Federal Parliament to enact remedial legislation in the interest of the Catholic minority. This ruling was contested by the Provincial Parliament, and the long slumbering sectarian embers were ignited.

To the people of this country the extraordinary view was offered in the Canadian Federal Parliament of a leading member of the most anti-Catholic organisation in existence introducing a Bill for the purpose practically of vetoing the legislation of the Provincial Assembly, and establishing a system of Separate Catholic schools which a province had almost unanimously declared it would not support or even allow to exist. On the other hand, there was witnessed the spectacle of a French Catholic leader of a political party throwing all his influence against a system of legislation which would be contrary to the wishes of the Provincial Legislature, taking the ground that as the question of education had been given to the province under the constitution, the question was one of provincial rights, and should not be vetoed or interfered with by the Federal authorities. When it is remembered that the respective attitude of these two leaders was taken in a country where the Catholic population is about 42 per cent. of the whole, it will be readily seen how complicated the situation naturally became.

The *dénouement* which might well have been expected, was reached at the General Elections which followed almost immediately. The honoured leader of a political party, himself a devout Catholic, who had given forcible expression against coercing the Provincial Assembly, was denounced by the clergy of his own province. All the influence of the Church was exercised against his candidates throughout Quebec. To the surprise, however, of everyone, when the ballots were counted, it was found that very nearly all the candidates supporting this political leader were elected, and that those supported by the clergy had been defeated. The decision was arrived at by the successful party, that if the clerical influence was to be allowed to assert itself in this form, responsible Government in Canada was doomed to absolute failure. Steps were taken by all the Catholic representatives in the Quebec Legislature and in the House of Commons to carry the case to Rome. In a word, the result was that an envoy or ablegate was sent to Canada, and upon his report special instructions were issued, by the authority of the Pope, discountenancing any action on the part of the clergy indicative of political influence, but was done in such a way as not to prejudice the clergy in the eyes of the rural or *habitant* population. This act on the part of the Holy See has undoubtedly retained for the dominant Church in Quebec the cordial sympathy and loyal support of that vast body of parishioners noted for their religious zeal, for their devotion to its institutions, to say nothing of securing to the Church the hearty co-operation of those who, although politically in conflict with the hierarchy, yet retain for their Church all the fervour and love which has won for the Catholic population of French Canada even in Rome the reputation of being the most spiritual and religious in the whole Catholic world.

The character of the French Canadian peasant at home is one marked with frugality, thrift, and sobriety. In few countries is there a higher standard of morality among the population, and in none is there a deeper sense of religious conviction. Intelligent, bright, and clever, he easily adapts himself to a wider life. He has not been by any means slow in receiving impressions. He is quick to see that there is opened for him a wide field of usefulness. He has a high ideal of political honour, without that strong attachment for one or the other political party, *per se*, which is so marked a characteristic of the Anglo-Saxon race in Canada. The personal influence of a leader has probably greater weight with him than what might be described as his political ties. The suspicion of any failure on the part of their champion to keep a record untarnished has been surely succeeded by lessened confidence if not downfall. In their natural admiration for one of their own race, and one of their own religion, they are as sensitive of the retention of the highest standard of political morality and honour as any class of electors in any part of the British Empire.

All these phases of the life and character of the French Canadian are a sufficient reply, I submit, to Englismen who are disposed to raise the question as to how far the Empire can trust these sons sprung from a once hostile race. Even from the low plane of selfish interests, and I would be sorry to make the statement entirely on that ground, French Canadians in Canada must remain loyal. The privileges they have enjoyed in respect to Church management and government in the province, the recognition of their language as equally official with English in their own province and also in the Federal Parliament, could not be long retained under any other circumstances. If Canada were independent, sooner or later, constitutionally or otherwise, solemn compact or no between the different peoples, these privileges would disappear. In the case of annexation as part of the United States Republic, French Canadians could not hope to enjoy for any length of time, no matter how solemn might be the agreement, the privileges which they enjoy in all these respects in Canada. With the growth of population, under any of the circumstances referred to, conflicts between the races, added to political exigencies, would certainly arise, sooner or later, and bring about a change.

As long as Canada is a portion of the Empire, all the privileges which French Canadians enjoy will remain intact, for Great Britain always observes her treaties. But, over and above all this, the Empire cannot forget its debt to them in their proven fidelity on the battlefields of 1775 and of 1812-15. It must also not be forgotten that it was when a French Canadian Premier was in power in Ottawa that the first contingent of Canadians for service in South Africa was offered to the British Government.

A Cabinet secret has lately been revealed that the proposal to send a second contingent was first suggested by a French Canadian member of the Laurier Administration. It may be said, as has been noticed by the English Press, that there are those in Quebec who are opposed to this action on the part of the Dominion Government. It would be amazing if there were perfect unanimity on this or any other question where absolute freedom of discussion is always encouraged. That the Premier's province—the Province of Quebec—approved of his action in this particular is to be found in the result of the General Elections last year in the unprecedented return to the House of Commons of almost the entire representation from that province in his support is, I think, all the evidence that can be required to prove their fidelity to the Empire in the hour of need.

The question was raised in Canada when the first contingent was sent as to the wisdom of its being dispatched before Parliament was consulted. The French Canadian, probably more so that any other portion of the population, is extremely sensitive upon any apparent infringement of his rights and privileges. He desires that nothing shall be left undone to show and to prove that responsible government in its widest sense is operative, that there is no expenditure of any money without the consent of the people's representatives, that nothing less than the fullest measure of local government, together with the freest possible discussion upon all questions in or out of Parliament is their indefeasible right, and this position he upholds with all the characteristic fervour of his race. If, in this respect, therefore, the French Canadian is sensitive respecting the observance of all the constitutional rules connected with responsible government, I am sure he will be pardoned by the country possessing the "mother of Parliaments."

If time permitted it would be possible to give extracts from speeches of leading politicians and statesmen from the Province of Quebec to prove the attachment of these people to British institutions.

My object in this particular will be quite fulfilled if I may be permitted to quote the following extract from a speech delivered by Sir Wilfred Laurier at a banquet which was given to him in Paris in 1897:—

"We Canadians of French origin were separated from France last century not so much by uncertain fortune of war as by the supineness, the neglect, and the incapacity of the King of France . . . . but though separated from France, we have always made our love of her a religion; separated from France, though we have lost our share in her glory, we have achieved conquests in other directions which are dear to French hearts. . . . . Let me illustrate. In traversing your city, the most beautiful of all towns, I have noticed on the façades of your public buildings the device which the arms of the Republic carried across Europe—Liberty, Equality, Fraternity. All that this device contains of valour, of grandeur, and of generosity, we have to-day in Canada. Liberty, it is ours, absolutely and fully, more fully—pardon my national pride in affirming it—more fully than in any other country of the world. Liberty for our religion, its practice, its ceremonials, its prayers, and its ordinances, liberty for our language, which is the official language with English, liberty for our institutions, which our ancestors carried from France, and which we regard as of sacred origin. Equality, it is ours, and what greater proof could I give you than that in a country where the English race and the Protestant religion is dominant, at the last General Election a man was placed in power, a man belonging to the French race and the Catholic religion who has never failed to insist upon his race and his religion. Fraternity, it is ours. There is no domination of race by race with us. We have learned to respect and love those who formerly fought us, and to make ourselves loved and respected in return. The old hostilities have ceased; there is no longer any rivalry except that of emulation, and I say this of our fellow subjects of the English race, that they understand, appreciate and admire our national pride as descendants of France, and that they have no other feeling but that of respect for us.

"Of our old struggles there remains to the descendants of France one relic which we preserve with passionate love to-day, the flag of France—not of the France of to-day, but of the old monarchy—there is one tradition which we preserve to this day, that this flag waved victoriously for a whole day above the ramparts of Carillon when the Marquis de Montcalm repulsed the repeated assaults of the English army. This flag we carry in our Church festivals and our patriotic processions, and never has it occurred to our compatriots of English origin to make it a subject of reproach. If this is not brotherhood, in what does brotherhood consist? . . . I may be permitted now to make a personal reference. I have been told that here in France there are people who are astonished at the attachment I feel, and which I do not conceal, for the English crown. They call it here 'loyalism;' may I say, in passing, that I do not like this new word 'loyalism.' I prefer to keep the old French expression of 'fidelity (*loyauté*);' and indeed, if there is one thing that can be regarded as an attribute of the French race, it is this fidelity, this memory of the heart. . . . . We are, therefore, faithful to the great nation which gave us life, and faithful to the great nation which has given us liberty."

Looking at this question from the standpoint of one who has spent some years in public life, and who has had the honour of an acquaintance with many of the prominent statesmen of Canada during the last twenty years, it is a privilege to assist in rendering well merited justice to this large part of our population.

This loyalty is not of to-day. Its intensity dates from Lord Durham's solution of the difficulties surrounding the earlier government in Canada, and Lord Elgin's constitutional acquiescence in the enactments of the Canadian Parliament during his tenure of office. The latter made it very clear that the day of interference with the will of the people, from Downing-street, had passed. The sense of fidelity to the people of Great Britain exists because there is perfect liberty. We have those upon our side of the Atlantic who imagine they should be allowed to arrange your fiscal policy. You have those here who would change the relationship of the Colonies with the Empire. In Canada, perhaps more particularly in Quebec, the people have no desire for indefinite additional responsibilities which are occasionally suggested. They have vast problems of their own to solve in developing and protecting their heritage in North America, sufficient in magnitude to tax their resources to the utmost, as well as to try the genius of their statesmen. The English people may be assured that visionary or imperfectly matured schemes of Colonial Imperialism will not be hastily accepted.

There has always been an insignificant minority in Canada not unwilling to fan into flame the smouldering embers of racial and sectarian prejudice. This is quite natural in a country where the population is almost evenly divided between the different races with their differing forms of belief. Agitators under these circumstances manage to secure a prominence which they could not otherwise attain. The Dominion has passed successfully through the excitements incident to such conditions, and the sober second thought of the people has always been in disapproval of appeals to sectarian or racial prejudices. That, however, is purely a domestic question. It has proved to be neither dangerous to the interests of the Dominion nor to the Empire. Canadians believe that the problem of government, regardless of social or sectarian differences, has been solved in their country. Where national, political, and personal liberty prevails as it does in Canada, and is given its widest scope and its fullest measure, there can but follow in its wake national development and national progress, as has been most abundantly proved in the history of the Dominion. The people live in a wide atmosphere; they have laid the foundations of a federal constitution broad and deep; they have solved the details of provincial and State autonomy to secure a heartily contented and peaceful population. This position has been assured to them under British rule not only in the present, but for all time to come. Under such circumstances it needs no apology for claiming that throughout the British Empire there are no more loyal or trustworthy subjects of his Majesty, and none wishing more heartily to co-operate in maintaining the stability and prestige of the Empire, in the North American Continent, than that part of the people of Canada comprising the French-speaking population.

DISCUSSION.

The Chairman thought that after so admirable and eloquent an address, there was little left to be said. It was 63 or 64 years ago since he became first acquainted with the French Canadians, and he could bear testimony to the fact that they were the most hospitable of people. The French Canadians had been really loyal. They had had amongst them statesmen who would be considered amongst the ablest in any country. Fifty years ago or more, one whom he recollected very well, Sir Etienne Taché, said that the last shot fired on the continent of British America, in defence of the British flag, if it was necessary to fire that shot, would be fired by a French Canadian. Again, thirty years ago, Sir Georges Cartier, a very able leader of the French, said the only difference between Englishmen and Frenchmen in Canada, was that in the case of the one his mother tongue was English, and in that of the other French; but tha they were equally English in spirit and in devotion to the Constitution and to the Empire. It was quite unnecessary for him to say that the present Prime Minister of Canada was foremost among those who were doing such good work in bringing closer together the different parts of our great Empire. The Canadians had fought side by side with their English brethren throughout the unfortunate and sad war in South Africa, and had done their part well; not that they had assumed to themselves that they had done better than others because, where all had acted so nobly and bravely, it would be invidious to say that one had done better than another. As it had been in the past, so it would be in the future. There would be none more attached to the British rule, or more desirous of promoting the interests of the Empire than our good fellow subjects and fellow citizens, the French in Canada. With regard to the admirable report of Lord Durham, he had a distinct recollection of Lord Durham and his kindness to him. Lord Durham's stay in Canada was all too short. Political influences in this country demanded that he should return, but he left behind him a memorial of himself, which was not only for the good of that country, but which had assured much benefit to the mother country and to the whole of the Empire. The French Canadians were somewhat different from their brethren in Europe, and he thought that told very markedly in favour of the new country. In old France the population was increasing, if at all, very little indeed. It was almost at a standstill, and a family in old France of three or four was considered a large one; but in Canada a family of a dozen children or even of 20 was not at all unusual. In the province of Quebec an Act was passed, a few years ago, that everyone in that province who had alive a family of 12 should be entitled to 100 acres in addition to what he then held; and a very large number of applications was received. There could be no better argument in favour of Canada than that. It was desirable that people should be encouraged to go from this country into Canada. He trusted there would be a greater effort than had been made in the past on the part of those having influence throughout the United Kingdom to direct the stream of emigration to Canada and to other provinces and colonies of the Empire rather than to foreign countries. A very potent reason why emigration should be attracted to Canada was in connection with the food question, which was a most important and momentous one for Great Britain. It was said that Great Britain, left to itself in time of war, would be starved out in a month or six weeks. Canada was now able to export something like seven or eight million quarters of wheat; but by sending emigrants to Canada, and by doubling the population, in ten years more Canada would be able to furnish every bushel and pound of food that was required for the United Kingdom. Just now it was only a six days' voyage from England to Canada, but within another two or three years it was hoped the sea passage would be only four days, so that Canada was practically brought to our own door. Mr. Preston, as Commissioner of Emigration, in connection with the High Commissioner's office, was prepared and anxious to give every possible information with regard to Canada and as to its possibilities, he would only say in conclusion that it was a country with a population of 5½ millions, and yet capable of sustaining 100 millions.

Lieut.-General J. WIMBURN-LAURIE, M.P., said he had had the pleasure and honour of commanding French Canadians on active service, and better, more serviceable, and more willing soldiers he had never had under him. Another advantage he had had was that of being a member of the Canadian House of Commons, and he could speak highly of the French Canadians he met there. He had never known, during the whole time of his membership of the House, a Frenchman called to order. They were thoroughly constitutional members, most desirous to discharge their duty, so that rules of order were not required to be passed to make them behave themselves as, unfortunately, had to be done in another House. He was particularly pleased that an Ontario man had written the paper. Sitting one day in the House of Commons at Ottawa, a French Canadian member, pointing to a large number of Ontario men, and men of other provinces, said, "It is very funny; there was a time when our friends over there called us Canadians. Then it was not a term of such high honour as it is now. But now that the term Canadian is a term of honour, they are Canadians and we are French." He was glad to see that a gentleman from Ontario came forward to remind the French Canadian that he was as distinctly as much a Canadian as those who lived in the English provinces of Canada. He thought the French Canadian wanted a little encouragement from his English brethren; he wanted to be made to feel that he and they stood on the same plane, that they were inhabitants of the same country, and that jointly they had undertaken to make that great nation one of the greatest nations of the world. The French Canadian was a good neighbour, a good citizen, and one who would take his share in building up the country in which he and his English brethren were determined to live and to make a nation of.

Mr. A. C. FORSTER BOULTON, as a Canadian coming from Mr. Preston's own province, endorsed his remarks with regard to the virtues of the French Canadians. Perhaps the most important lesson to be learned from the paper was how it was possible to govern a great Empire composed of many different nationalities. That problem had been solved in Quebec by attaching to the British Crown an alien race, and it had been done by allowing that race to develop along certain lines of its own, not by attemptting to coerce it and compel it to live a life exactly the same as that of the Anglo-Saxon. At the battle of Paardeburg the Canadians were in the forefront and the first intimation that the Boers had that the British forces were so close to their lines as to command their entrenchments was on the early morning of Majuba Day, when the Boer sentries heard voices speaking French—the voices of the French-Canadian soldiers of her Majesty, who had come all the way from Canada to fight the battles of the British Crown in South Africa. The great national anthem, "God Save the King," came from the old French "Mon Dieu, sauvez le roi." That old song was no longer heard in old France, but its counterpart translated into English was sung to-day on the banks of the St. Lawrence, and he had every confidence in saying that nowhere throughout the length and breadth of the British Empire would the National Anthem be heard sung with more deep feeling, than by his Majesty's French subjects in Canada.

Mr. GILBERT PARKER, D.C.L., M.P., could not restrain himself from saying two or three things which appealed to him very strongly as he listened to the paper. The reader of the paper said that England had had a habit of keeping her treaties, and Mr. Parker believed that if one thing had steadied and made certain the success of England as a colonising power, during the last 120 years, it had been the fact that the integrity of the personal character of Englishmen had found its way into the integrity of the character of the Government. The reader of the paper had dwelt upon personality; personality itself was not sufficient. It did not necessarily follow that the personality of the present Premier of Canada alone would be able to command the admiration or the devotion of a number of people, or of a party. It was because he represented a people and the best instincts of the French Canadian people that he held the position he did. In the election of Sir Wilfred Laurier to be Premier of the Dominion of Canada, the final seal, technically, was set upon the confederation of Canada, because it proved to the world that one could be taken from the minority of the population, from what might be called so far as language was concerned and origin, a stranger people, to command and lead an amalgamated people in a great dominion like that of Canada. In the fact that Sir Wilfred Laurier was Premier of Canada lay the best test not only of the confederation but the quality of mind which went to make up the Constitution of a country governed by the British flag, and that he believed was what would obtain wherever the British flag went.

Mr. HAROLD SPENDER thought the most amazing thing to an English visitor to Canada was the loyalty of the French Canadian. The English visitor heard him speak French, saw that he was full of French instincts, that he was attached to the French tricolour, and yet could have no doubt as to his loyalty to the British Crown. There was an absolute conviction amongst French Canadians that they would rather be under English rule than any other rule in the world. French Canadians were not of the modern French; they were pre-revolution French, the Frenchmen of the old *régime*. They had no more in common with modern France than Englishmen had; they hated the Revolution and their thoughts harked back to the old *régime*. But there was another cause for their loyalty, and that was their nearness to the United States. They disliked the moulding power of the United States. They saw across their border the great steam roller of the United States destroying language, religion, custom and everything, and stamping its great hall-mark on everything that came within its borders. There were now a million French Canadians living in the United States. They desired to come back, and most of them did come back in their old age, which he thought was adequate proof that they preferred British rule to the rule of the United States. The devotion of the French Canadian was also due to the absolute fidelity with which the English race had observed the obligation into which it had entered; and if the day ever arose when these obligations were broken, then England would have precisely the same trouble in Canada that she had in South Africa. The day there was any interference with their language, their customs, their religion, or their law, their loyalty would begin to crumble.

Mr. HOWARD A. KENNEDY congratulated the reader of the paper on the way in which he had performed his task, because all the French Canadians and English Canadians did not live in absolute harmony together and love each other as much as was desirable. He had lived ten years in the Province of Quebec, and gone about amongst all classes of the population, and he was bound to say there was a small minority of French Canadians, who, although passively loyal to the British Crown, cherished an ambition for a time when there should be no alien rule, no British Government, no American rule, nothing but a pure French Canadian rule in the North-East of Canada. That sentiment was hardly ever found except among people like lawyers and journalists. The ordinary people were perfectly contented, and acquiesced in the present state of things. Any independence of the French in Canada would be not simply independence of this country but dependence immediately on another country; it would be falling out of the frying-pan into the fire, and the fire would be very much hotter than the frying-pan. Unfortunately, although it was true that education had made progress in French Canada, the quality of the education in the common schools was often deplorably poor. As to religious tolerance, an Englishman living alone in a French Canadian village might be regarded as a sort of patron saint, and might even be made mayor of the municipality, but where the French and English were more equal in numbers there was not quite such a harmonious feeling.

Captain **Bernier**, who described himself as a French Canadian of the new school, said that two millions of French Canadians every day, when saying their prayers, added, "God bless father, God bless mother, and God bless the King." When such a sentiment was instilled into the young hearts, it was difficult to eradicate it. French Canadians were loyal to England, because they had been well treated by her, and were proud of the freedom they enjoyed in Canada. His ambition was to increase the territory of Canada by annexing the North Pole, and with that view he offered himself to the Queen in 1896, and had now offered himself to the King. All he required was a few screws from Mr. Chamberlain to fasten the British flag on the pole. He agreed with all the Chairman has said with regard to emigration, especially in its bearing on the food question.

The **Chairman**, in thanking Mr. Preston for his valuable paper, referred to what had been mentioned as to the possible aspirations of the French Canadians for an independent Government of their own, he had had a long acquaintance with both the English and French Canadians, and he was convinced that there was no desire on the part of any, except it might be a very small minority—not one in ten thousand—to live under any other conditions or relations with respect to Government than those they enjoyed at this moment.

Mr. **Preston**, in reply, said he had lived amongst the people for many years in the closest possible association, social and political, and had never heard the suggestion made by any prominent person or by anyone else, that there should be established on the banks of the St. Lawrenee anything in the form of a French Republic, or that there should be any separation from Great Britain. With regard to the educational system, he admitted that in Quebec it was not as perfect as he would like to see, but then it could also be said that the educational system in England could be improved. The same thing might be said of Ontario, where people imagined they had a perfect system. One fact, however, carried its own weight, namely, that from 85 to 90 per cent. of the judges, the clergy, the editors, and Members of Parliament, and professional men in Quebec had come from the peasantry, or from the working classes, and their education had been commenced in the elementary schools and continued in the high or grammar schools and the universities of the province. He did not know any other country in the world which could produce, as Quebec had done, so large a proportion of their public and professional men from the peasantry. He was living in hopes of seeing the time when the people of Canada would appreciate what Lord Durham and Lord Elgin had done for them in the establishment of the magnificent system of responsible government which the Canadians enjoy, by the erection of statues to their memory in the Parliament grounds at Ottawa. In the same sense he also desired to see in Great Britain some public recognition and appreciation of the great work which General Wolfe did when he undertook to attack the French army upon the plains of Abraham. As Sir Wilfred Laurier had well said, North America was deserted by the French Government; but, nevertheless, this warrior with a courage the like of which had not been excelled in the annals of the British army, scaled those heights and won for England a larger extent of territory than was ever bequeathed to a nation as the result of a victory by any general of modern times. A statue of Wolfe should have a place with the other great heroes in Trafalgar-square.

Major-General Sir **Owen Tudor Burne**, G.C.I.E., K.C.S.I., proposed a hearty vote of thanks to Lord Strathcona for taking the chair, which was carried unanimously.

TWELFTH ORDINARY MEETING.

Wednesday, February 26th, 1902; Sir **Owen Roberts**, M.A., D.C.L., F.S.A., Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Cardona, Joseph, jun., 1, Church-street, Gibraltar.
Cook, James B., Ph.D., Randolph-building, Memphis, Tennesse, U.S.A.
Cowie, Archibald, Messrs. Cowie Bros. and Co., Glasgow.
Dale, Charles Ernest, care of Sir Charles R. M'Grigor, Bart., and Co., 25, Charles-street, St. James's-square, S.W., and Southern Nigeria, West Africa.
Frames, Minett Edward, F.G.S., P.O. Box 3517, Johannesburg, Transvaal Colony, South Africa.
Gates, Elmer, Chevy Chase Circle, Washington, D.C., U.S.A.
Harris, Lloyd Price, M.I.Mech.E., 32, St. Leonard's-avenue, Bedford.
Holmes, Charles R., 28, Sutton-court-road, Chiswick.
Jenney, William Le Baron, 520, New York Life Building, 171, La Salle-street, Chicago, U.S.A.
Knoblauch, Louis, 22, Baltic-street, Leith, Scotland.
Macfarlane, Walter, 22, Park-circus, Glasgow.
Moung Oo Gah, Yedashe, Burma.
Rea, Samuel, Bryn Mawe, Montgomery County, Pennsylvania, U.S.A.

The following members were balloted for, and duly elected members of the Society:—

Barron, Claud Alexander, I.C.S., Kohat, Punjab, India.
Frankland, Frederick William, New York Life Insurance Company, 346, Broadway, New York, U.S.A.

Gupta, Professor Manoranjan, B.A., Kalia, Jessore District, Bengal, and St. Andrew's College, Gorakhpur, N.W.P., India.
Milsted, W. P. S., Armenian College, Calcutta, India.
Seear, J., The Quarry, Cheam, Surrey.
Small, Professor James Willoughby, F.G.S., Victoria College, Jaffna, Ceylon.
Smith, Herbert Guildford, P.O. Box 73, Lowe's-building, East London, Cape Colony, South Africa.
Subbiah, P. V., Gopalasawmy Coil, North Street, Palamcottah, Madras, India.
Wallace, Alexander Falconer, 20, Hyde-park-gardens, W.
Watermeyer, Vipan Maitland, P.O. Box 398, Public Works Department, Pretoria, Transvaal Colony, South Africa.
Webb, John Frederick, 63, Queen Victoria-street, E.C.

The paper read was—

RECENT INVENTIONS IN WEAVING MACHINERY.

By Prof. Roberts Beaumont, M.I.Mech.E.

Weaving machinery, strictly speaking, consists of the various types of looms employed in the production of woven fabrics by a process of interlacing two series of threads, technically known as "warp" and "weft."

The ideal of Cartwright, the inventor of the power loom, was to devise mechanism which would perform the elementary operations of weaving, namely, the division of the threads of warp in regular succession for the passage of the weft or crossing thread; the forcing of the shuttle, which contains the same, from side to side of the cloth; the delivery of the warp, and take up of the fabric.

It will be readily understood that to produce simple texture, no intricate series of automatic parts is necessary, but the modern loom, in addition to being a weaving machine for interlacing yarns or threads at right angles to each other, is required to develop in the texture, design, due primarily to varying the systems of crossing warp and weft; and secondly, to the distribution of colour on any part of its surface.

Mechanical motions more or less involved in construction must ensue in devising a machine like the loom, competent of controlling individual threads in the building up of component parts of a design, maintaining these at a uniform tension, regularly delivering them, and winding up the fabric when woven; stopping the loom without the interference of the weaver on the cessation of a single thread in a mass of some thousands, or a discontinuance of any one of the several colours of weft yarn threaded into the cloth by the shuttles.

To observe a loom weaving a pile carpet, selecting automatically the threads of the required colour to form the pile in any given part of the carpet, and inserting underneath these wires, which at the proper time will cut them, leaving one dense mass of fibre; systematically delivering up the requisite lengths of yarn of the appropriate colour to make the pile; and finally taking up the carpet in the proportionate lengths in which it is woven; suggests both to the expert and to the uninitiated, mechanism which it would be difficult to surpass by other examples of human inventiveness

The subject will be made clearer if the inventions to be treated of are grouped as follows:—

I. Mechanism for controlling the development of a texture concurrently with the production on its surface of design, whether elementary or complex in character.

II. Motions for actuating the shuttle carrying the weft yarn.

III. Mechanism for the warp let off, and take up of the fabric.

IV. Mechanism for the automatic supply of weft yarn.

V. Mechanism for the immediate stoppage of the loom, on the discontinuance of weft or warp threads.

VI. Special motions as applied to looms for the weaving of pile, velvet, and fabrics in which the pattern has an embroidered appearance.

There are recent inventions under each group of so distinctive a class as to deserve consideration, and they will be dealt with in the order named, but those comprised in I. IV. and VI. are of the most distinctive character, and will be chiefly discussed.

I.—Mechanism for Controlling the Development of a Texture concurrently with the Production on its Surface of Design, whether Elementary or Complex in character.

This is always a most important part of the loom, affecting the evenness of the cloth, its structure, and the nature of the pattern developed. The term "shedding motion," or division of the yarns, has been applied to this mechanism, and comprises the following well defined motions:—

(1) The tappet or eccentric.
(2) The lever or dobbie.
(3) The Jacquard or harness.

(1) One kind of tappet motion is practically the same as when invented by Cartwright, and the other as invented by Woodcroft, but in the dobbie and Jacquard, though the elementary principles have continued, yet the improvements have been so considerable as to entirely change the principles of construction.

(2) This type of motion for shedding in the warp is constructed on two well-known systems. First, it will be clear that in weaving a fabric the threads need not necessarily change positions for the insertion of each separate pick or shot. This is only absolutely demanded when producing the simplest of all fabrics with alternate crossings of warp and weft. Knowing this, the machinist has constructed motions for opening the warp, which will retain the threads for the required number of picks, in either the upper or lower position through which division the shuttle passes; the later type of machine has been for this purpose.

The dobbie has not, however, only the simple function to perform of lifting and depressing the heald shafts. These must be operated at a minimum amount of vibration, and be positive in both their upward and downward action. Any jerk at the initiation or termination of the traverse is a serious disadvantage in weaving fine counts of yarn; yet the traverse must be rapidly effected. The mechanism for changing the controlling levers is part of the most delicate and complex of the machine. As a loom may have a speed equal to 100 to 120 transitions per minute, and each heddle may determine the simultaneous movement of from 400 to 500 threads, there is scope for the exercise of ingenuity in the origination of shedding devices.

Without making any comparisons between machines which compete very closely with each other in the production of fancy, but unfigured fabrics, the recent improvements in what is termed the "Keighley" dobbie, as made by Messrs. George Hattersley and Sons, Limited, and by Messrs. George Hodgson, Limited, are such a marked advance in preventing inaccuracy of control of the shedding levers that they deserve special definition.

In analysing the construction of such a machine (Fig. 1)* it is advantageous to commence with the lifting bars, B1 and B2, which oscillate backwards and forwards in succession and engage the jack levers, J1 and J2. In order to obtain rigidity of movement the bars slide within the slots. It will be noticed that the ends of these levers are hooked, and as to whether they shall engage the bars and in which direction they shall be actuated is determined by the pattern chain which revolves round the cylinder C. The levers J1 and J2 are secured at their ends to the lever L, which slides on a movable centre. This in turn is fastened by the rods R1, R2, to the T-shaped lever, the projecting arm of which is so connected with other parts of the loom as to rise and fall alternately, imparting a come and go movement through the rods R1, R2, to the bars B1 to B4.

The placing of the lifting bars at an angle instead of horizontal, has resulted in minimising the liability of not engaging known as "mis-lifts," preventing the development of faults in the woven texture.

Beyond this improvement, there has not been for some time any radical change in the shedding motions, whether built on this scheme of parts, or on that known as the "American" principle, made by Messrs. Hutchinson, Hollingworth and Co., Limited, either in this or other countries.

(3) The Jacquard is the next form of mechanical motion for regulating the lifting and depression of the warp threads. In the main elements of its construction, it remains practically the same as when originated by the combined efforts of Falcon, Vaucanson, and Jacquard. Still, marked advances have been made in the adjustment and design of the motive parts, which have afforded additional possibilities of fabric production and ornamentation.

It is not many years ago when the Jacquard was only capable of lifting the warp threads in order to divide them to form the shed. Even to those unaquainted with the weaving process, it will be clear that if threads only travel in one direction when separated for the shuttle, such yarns as are actuated by being drawn at an angle, have greater tension put upon them than those threads remaining stationary. One of the most difficult objects to attain in Jacquard weaving was that of causing the yarns to travel the same distance whether highered or lowered; the Ainsley's machine being one of the first invented to do this.

Latterly it has been sought to obtain a reliable Jacquard in which threads of warp lifted would, as required, remain stationary in the upper position. Several attempts have been made, with partial success, the chief difficulty being to acquire certainty of action. It was quite feasible to control the wires for holding the threads, but not so easy to cause them to release their hold when required. An invention which has effectually accomplished this is that of Stafford and Kelmel. (Fig. 2.)

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* See note at end of paper, page 310.

In the ordinary Jacquard, each upright wire which lifts a series of harness cords, has its movement determined by a single cross wire or needle, the rear end of which is under the command of a spring, and the front end operated upon by a card containing blanks and perforations, an endless series of which, representing the pattern, pass round a four-sided cylinder. But here, each upright is in duplicate and possesses two hooks so that there are two series of lifting bars, A, A, for engaging these hooks.

The essential idea in this invention is to have a hook in the upright wires, other than for lifting purposes, one that may be engaged by what may be defined as the "holding up" bar C. Once resting on this bar, it will remain there so long as the cards carried against the cross wire contain perforation, but a blank would force it back exactly at that timing when the pulley was passing up the eccentric part D, causing the cross wire S to be forced backward, and carrying the hook off the lower holding up bar C. Therefore, whilst the retention in the upper position is absolutely certain, the depression is equally positive when any upright is required to be forced off the stationary bar.

Another modern improvement in the Jacquard machine which has been necessitated by the intensity of competition, has contributed to the possibility of weaving at intervals, as desired, designs which would form stripes across the fabric, or, as in certain textures, change from a centre to a border pattern in succession throughout the weaving of the piece. On the old principle, when a transition had to be effected from one style of pattern to another, the numerous cards for one design had to be removed from the loom, and replaced by a second series. Inventors have endeavoured to reduce the amount of labour thus involved in the use of two cylinders for bringing the cards into action; the usual arrangement is to have one cylinder operating in the front, and the other in the rear of the loom, each carrying its own set of cards, which could be brought into use by mechanism, as the requirements of weaving demanded.

This, however, cannot be considered to be an ideal arrangement, though undoubtedly a great advance upon the older system of changing from one set of cards to another, manually. It is desirable, as far as possible, that each set of cards should be equally within the vision of the weaver, and with this object in view, Paton's improvement has been designed.

In an invention of this kind there are two principal functions to be attained:—

(1) The changing of the active cylinder;
(2) To accomplish this when a required length of fabric has been woven.

There are, therefore, two series of parts, first, for directly changing the cylinder, and second, the registering plate, which can be set to measure the cloth according to the number of repeats wanted of each design; the former having their movement determined by the latter. (Fig. 3.)

Both cylinders are placed in the front of the machine, and one over the other, the upper one being slightly more forward than the lower one, so that there is ample room for the two series of cards. The mechanism for actuating these consists, in the first place, of the upright connecting rod F, which is under the control of eccentric movement, so that it rises and falls alternately.

The catch B is a duplex one, the upper hook engaging the projecting pin of the lever A^2. It follows that on the lowering of F, if it should engage D', lever A' would draw forward the lower cylinder C, pressing back its spring, on the disconnection of A and D', the movement of C' would be reversed, and A^2 would engage D^2, and bring cylinder C^2 into action.

As to which catch shall operate, this is determined by another series of parts primarily governed by the fabric wound on to the piece beam. The star wheel, E, with its connecting rods to the double catch, is secured by cord or wire to the projecting pins P, P', which rest on the periphery of the registering scale (Fig. 3A.) When P enters the recess of this cam, it effects a change in the position of the star wheel. If required, the connection with the star plate can be with one of the lifting levers, and then the cylinders can be changed for alternate picks.

For simplicity of parts and accuracy of action this is one of the most improved methods o using two card cylinders, both being equally accessible to the weaver and yet under the movement of the positive take-up roller, so tha the changes from the design on one set o cards to the other is effected automatically without any thought or attention on the part o the weaver.

IV.—MECHANISM FOR THE AUTOMATIC SUPPLY OF WEFT YARN.

In the ordinary power loom for the weaving of plain and elementary fabrics, the difficulty for many years has been to initiate an improvement which would result in greater productive power. Experiment and experience alike have demonstrated that beyond a certain speed, it is undesirable to attempt economy by higher running power, which always applies additional strain to the warp, and augments the vibration on the motive parts of the loom. If the maximum speed of a loom has been attained on a given quality and fineness of thread, the problem arises, in what direction are further advances to be made in the construction of power looms for weaving simple types of fabrics.

The builder of looms, as well as the student of weaving, has for some time realized the loss of time necessitated in the re-charging of the shuttle with weft yarn. It is well-known that weavers have become so adept in certain branches of the trade, that providing the loom is running comparatively slowly, they can change the shuttle without stopping the loom. But in cotton fabrics and other textures where high speed is needed, such a change of shuttle manually is quite out of the range of possibility.

Other methods of conveying the weft into the warp than by the use of the flying shuttle have been attempted. For example, an almost unlimited supply of yarn on huge bobbins has been placed at each end of the loom, and by means of a small carrier, lengths taken across the warp. In other instances the shuttles have had a rotary movement. But the difficulties of weft insertion in weaving, binding any series of intersections with the warp which the loom may prescribe, have so far proved beyond solution by any more efficient means than the common shuttle.

Accepting the shuttle as the most practical weft conveyer yet devised, the modern loom builder has in two ways endeavoured to provide a continuous supply of weft during weaving.

(1.) To eject from a shuttle a spent bobbin and insert a full one.

(2.) To eject a shuttle containing an empty bobbin and replace it by one containing a full one.

The merits of the two systems need not be discussed beyond that the first appears to be the more direct and has been developed to such an extent that between 70,000 and 80,000 looms have been made on this principle by the Draper Company of Massachusetts. It is to be regretted that the English loom manufacturer was not as open minded in regard to new principles of weaving as his *confrère* across the Atlantic; and it is not gratifying to national enterprise, considering that this country is the one in which power loom weaving, automatic spinning, and automatic machinery for the finishing of woven fabrics, originated.

As the Northrop was the first in time, it may naturally be considered before shuttle changing mechanisms. It must be allowed that the Northrop idea when first attempted was a bold one, but it was competent, more than any other improvement of recent years, to effect much economy in the weaving of plain fabrics. It has so far reduced the amount of time which the weaver has to give to each loom cotton fabrics, that he is capable of running twenty looms, where on the ordinary system, four to six was considered the maximum. To change from one bobbin to another in a shuttle without removing it from the shuttle box, and the loom running at full speed, making 190 to 200 shots per minute on a 28″ fabric, is to say the least, a mechanical triumph.

Moreover, it is not the mere ejection of a bobbin from a fixed position in the shuttle, but the insertion in its place of a second bobbin of weft, which the movement of the shuttle thread in such a way that it is delivered from the shuttle at the proper tension during weaving. Both operations had, before the Northrop loom was a success, been regarded as the work of the weaver. To effect the ejection of the shuttle does not appear so difficult as the guiding of a pliable thread into the small eye of the shuttle, which first acts as a guide to the yarn as it is delivered from the bobbin, and second, applies the necessary tension. If the loom had to be arrested for a short time whilst these changes transpired, the invention would not be so remarkable.

Northrop's motion consists of a revolving hopper charged with 14 or more bobbins, so arranged that when a bobbin is taken from the hopper and forced into the shuttle, the thread is retained at such an angle that on the shuttle leaving the box it glides into the shuttle eye. This is so formed, that once the yarn has passed into the groove, it cannot be drawn out of it except by breakage. Secondly, the motion of bringing the shuttle-box into exactly the right position in relation to the circular hopper, to make it possible for the change to be accurately accomplished, and this, when the shuttle is travelling at an actual speed of 170 yards, and the shuttle-box or going part at 50 to 60 yards per minute; the speed of the shuttle-box is here calculated on the time occupied in traversing from side to side of the warp, deducting the time it is retained in the boxes. (Fig. 4.)

What has to be done is the removal from the hopper, H, one of the bobbins, B, and the placing of it in the shuttle in the box, C, forcing the spent bobbin into the receiver, R. All the parts are under the control of the weft-fork, F —at the opposite end of the loom to the hopper —fixed on the shaft, S, and which, on the weft breaking, slightly oscillates and causes the pin, P, to raise a small lever, D. This lever on rising is forced against a projection, E, which brings the lever or hammer, A—whose projections have been slightly lifted above the ends of the bobbin—into action. This takes the bobbin, B1, from the hopper, H, and places it exactly parallel with the bobbin, B2 (Fig. 5), in the shuttle, rapidly pressing B2 out of the shuttle, which is guided into the receiver, R, by a metal plate, E, which, during the process of changing, is brought into the position shown. Re-charging having been effected, the transferrer, A, is drawn back, and allows the hopper to travel the distance of one bobbin forward.

In one type of Northrop a small lever or finger, known as the "feeler," is constantly touching the weft on the bobbin as it enters the shuttle-box, and when only a few layers of weft are on the same, it brings these changing parts into operation; but in others, change occurs on a discontinuance of the weft only, whether this be due to breakage or to the bobbin being empty.

The makers of the Northrop loom also attach a warp stop motion, which was the dream of Cartwright, and on which inventors have spent much time without success. The only two motions of this kind in use are that of the Draper Company and of Poyser, the latter being applied as yet only to small-ware looms. It is questionable whether either could be adopted with any degree of utility in the weaving of ordinary fabrics made of wool, worsted, or silk yarns. They both depend upon what may be termed, "droppers," though essentially different from each other in principle.

In the Northrop, steel droppers are applied to the heddles, which may be of the two types given. (Fig. 6, A and B). This is sound in principle, as every thread has to pass through a separate mail in the heddles. The lower end, in the Northrop heddle, is free.

A second method is to use a drop wire between the heddles and lease rods, in which case each heddle serves as detector for two or more threads.

A third type is a detector for each thread, which necessitate more expense in drawing in.

Where the heddles, or a separate steel plate is used, when a thread of warp breaks, the heddle drops. The steel heddle, H, dropping, engages plate C, bringing it into such a position that a projection on the going part engages D, forcing E in the direction of F, which releases the setting on handle.

To obtain a constant supply of weft, English and Continental inventors have adopted the principle of changing the shuttle, and not the weft bobbin only. Several motions have been constructed for doing this, three of the most important being those of Crossley, Hodgson, and Hattersley. They all derive movement, like the Northrop, from the weft fork attachment. In both the Crossley and the Hodgson, the used shuttle is removed and replaced by one containing a full bobbin while the loom is running, but to change the shuttle by Smith and Hattersley's invention the loom is, for a brief period, ingeniously made inoperative and then automatically re-started.

Detail reference need only be made to the motions of Hodgson and Hattersley.

The shuttles charged with the full bobbins of weft are placed in a receiver (2) fixed on one end of the loom rail. (Figs. 7, 8, and 9.) Each shuttle has in turn to be lowered on to the carrying plate (8), the upper shuttles being held in position by the side springs (4 and 5), so that plate 8 may be borne forward by the lever 6 placing shuttle 1 on to one of the divisions in the X-shaped box 9, free to revolve in the shuttle-box of the loom.

The sequence of movements may be briefly defined. On a breakage of the weft yarn, the weft fork operates on the slackening rod 18, carrying lever 17, causing 12 to be engaged by catch 15, which is secured to the sword 14 of the going part. One immediate effect is to move forward parts 6, 19 and 27, all on the rocking shaft 11. The first of these brings with it the shuttle plate 8, and forces the shuttle on to the projection 9, and continues to give a partial rotation to this box bringing it into line with the shuttle race. Finger 19 engages the curved or cam surface 20, pivoted on the end of the shuttle box, taking the cking projector 22 from the locking disc 23. Vhen the shuttle receiver has made a quarter f a turn, it is steadied by lever 24 pressing on ne of its sides under the control of the spring 5, which connects this lever with arm 26 on e casting 21. (Fig. 8 and 9.)

To facilitate the entrance of the new shuttle nto the box, the spring 30, which during ormal conditions prevents the rebound of the huttle, is freed by finger 27 coming in contact ith 28 on the stop rod 29. This rod simulaneously operates 33 and 35, raising or lowerng the front part of the box.

This motion has been running successfully n looms speeded up to 200 picks per minute.

The Hattersley automatic shuttle feeding nvention is of quite a different type, both as egards driving and the scheme of mechanical arts. It is governed by a series of tappets, ffecting in succession the stoppage of the oom; the ejecting of the used shuttle; the lacing of the new shuttle in the box; and the e-starting of the loom.

These tappets revolve loosely on a low shaft f the loom 2, the outer wheel of which W3, is riven by intermediate W2 by wheel on the ain shaft W1. A non-delivery of weft yarn rings the weft fork into action, so that the etting on handle, by intermediate parts, auses the tappets T1 to T4 to be locked to a ircular recess plate on the tappet shaft, and hich are held together by the spring S1 astened to lever E. (Figs. 10, 10a, and 11.)

What has to be effected here, is, first, to rce a shuttle out of the shuttle box; second, lift the front of the box W; third, to take om the receiver R, and place within this box charged shuttle; and fourth, to re-start the om.

As stated, these results are obtained by eans of four tappets T1 to T4, shown in secon, and also in the elevation of the loom. he motive parts of the loom having been rrested on the breakage of the weft or a obbin run off, the driving strap is changed om the fast to the loose pulley, setting the heels W1, W2, and W3 in motion, and ausing a projection to enter into the recess of e wheel on the tappet shaft 2, thus giving otion to tappets T1 to T4.

Tappet T2 is the one for ejecting the shuttle. engages lever F, which by lowering upright , presses forward the elbow lever A, strikes e pin V, forcing it forward, and pushing the uttle out of the box.

The tappet for moving forward the receiving x B to meet the batten B.R is T1, engaging lever B, connected to H. When the shuttle is being changed W rises, owing to tappet T3 engaging G1, lifting through levers O and V, the front of the box W.

To restart the loom, tappet T4 engages E, fulcrumed on I, which through suitable connections, operates the setting on handle which transfers the strap from the loose to the fast pulley.

All mechanism governed by tappets is positive and steady in action, and hence in this invention there is regularity of speed and absolute certainty of change of shuttle as required.

It will be noticed that on these principles of having charged shuttles in a receiver there is one disadvantage as compared with the Northrop, namely, the shuttles have to be threaded on the old principle by the weaver. Of course this is no detriment as regards the weaving, but it is one particular in which the action is less ideal than where the bobbin is inserted into the shuttle and instantly threaded by mechanical means.

A fact that should not be over-looked in the use of these devices for making the loom automatic as regards the supply of weft is, that the pieces are fuller of defects due to what are termed "broken" picks or shots. In commercial practice, a weaver changing the shuttle by hand is under a system of fines for faults of this nature, but as mechanism cannot be coerced by the same measures, the saving in wages has to be adjusted to the loss, whether small or great, arising out of these causes.

Motions for Detaching Shuttle-boxes and Lathe for Looms in which Wires are used to form the Pile.

Regarding inventions applied to looms for special styles of fabrics, such as velvet, swivel, and lappet, I shall only refer to two, one the work of an English, and the other of an American machinist. These have been selected as suggestive of new developments.

First, the invention of Mr. Hollingworth for looms used in the weaving of fabrics, in which wires are inserted into the warp to produce a pile effect, as in a carpet, velvet, aed plush. Here, wiring may be facilitated by separating the reed portion of the batten from the parts carrying the shuttle-boxes, providing more space for the wiring motion. (Fig. 12.)

The chief mechanical difficulty in such disconnection of parts—which in ordinary looms are combined—consists in securing a relative timing of the reed and shuttle-box, so that they will be perfectly level with each other when the picking motion driving the shuttle forward, comes into action. Any failure of this would result in the shuttle not travelling in a straight line, and diverging out of its course.

Mr. Hollingworth separates the reed and the boxes and re-adjusts them in such a manner that there is little possibility of these defects arising.

Fig. 12 will show what has to be effected. The lathe and reed R have to be detached at a certain period in their forward traverse from the shuttle boxes S, the latter remaining stationary until parts R in their return movement exactly coincide with S.

As seen, R swings on an upright lever C, oscillating on a low shaft D, controlled by the usual crank shaft H and connecting arm B. The boxes are fixed on upright E (Figs 13 and 13A). Here two positions of the reed and batten are shown. In Fig. 13 the shuttle part is being met by R; and in 13A, by the action of B and slotted lever, the two have been made to coincide.

By the slotted lever C which oscillates to and fro, and the pulley fixed on arm B resting in the slot, a variable speed is transmitted to the upright on which these parts are mounted; thus, as the shaft of C revolves in the direction of the arrow, its speed decreases until it gets into the position shown in Fig. 13A.

In Figs. 14 and 14A the cams C are shown in the two alternative positions; in the first instance, it is bearing against the surface of the frame work and preventing the shuttle boxes from moving forward; in the other the crank A is in the backward position, having drawn the reed in a line with the shuttle boxes.

The motions, therefore, are as follows:—The crank arm D, operated by the crank A, forces forward through the slot and small pulley connection, E carrying the lathe and the reed. This accomplished, the arm returns to the backward position, bringing the lathe portion under S, which is being held stationary by the cam C.

The parts are skilfully designed, and effect in an efficient way the separation and re-adjustment of the lathe and the shuttle boxes.

NEW TYPE OF SWIVEL LOOM.

In the ordinary build of loom for swivel weaving, the shuttles are in a frame secured to the rest of the batten, and may be lowered in different parts of the warp, within certain limitations, and made to figure the fabric. After having inserted the weft, they are raised from the warp, the two operations of lowering and rising occurring alternately.

The object of the invention of Mr. Hutchins, of Worcester, U.S.A., is to substitute the ordinary shuttle, by shuttles having a needle or pointed appearance, and normally in a line with, instead of at right angles to the warp, and forming one continuous series of shuttles from side to side, arranged as shown in Figs. 16 and 16A. In one instance, the shuttles S have made the traverse to the right, and in the other, to the left; the dotted lines showing their normal position.

The position of this shuttle frame in relation to the going part is shown in Fig. 17A, where S is the shuttle, A the sliding bar, B the fixed rail, C the lower part of the batten. Fig. 17 is simply another form of the same parts carried by each shuttle. A small bobbin is mounted on a spiral spring to prevent irregular delivery of the weft, and also possesses side springs bearing on the weft yarns.

The shuttles have, first, a sliding movement, oscillating as shown from the position in Figs. 16 and 16A, controlled by the levers S L fulcrumed at the end. Second, a bar on which they are fixed, A, has to rise and fall at given periods, lowering and removing them out of the warp alternately. The first is governed by an eccentric grooved drum, which is on a low shaft of the loom, and is only intermittent in action, the parts which engage it being connected with and under the control of the Jacquard or dobbie. The sliding bar A (Fig. 15) is secured to the elbow levers D, D1, one on either side of bar A. The other end is fastened by cords E, E1, passing round pulleys F, F1.

At the bottom, in the centre of the loom, both cords are attached to lever G, which is so pivoted as to swing in a horizontal frame. The other end of the lever is mounted with a pulley working in a groved drum. Obviously, as this lever oscillates from side to side, as the drums revolve, through the cords E, E1, it gives the requisite lateral movement to A, through levers D, D1.

The raising and lowering of the frame is done by cam and lever mechanism, the end of the lever being shown at H. Then this is engaged by the cam, through the connecting rods I, I1, fastened to D, the frame on which are the shuttles.

The side traverse motion is effected by a somewhat similar method to that of the needle bars in certain types of lappet looms where the lappet wheel is of an eccentric form coinciding with the movement required to develop the figure or pattern in the fabric. An eccentric cylinder or drum is used for this purpose. The chief advantage of the invention is the frequency with which the swivel shuttles may figure the fabric, there being three or four to the inch; and second, in the indication of their entrance into the warp by the Jacquard, so that they may be retained in or out of action for any period demanded. (Fig. 18).

One loom which has not been described, but which contains undoubtedly some of the most radical changes in weaving mechanism which have been attempted since Cartwright's inventions, is that of the Poyser small-ware loom. Having treated of this subject elsewhere, I only purpose contrasting its schemes of mechanism with those of the most improved modern loom. In design and construction it is a departure from all known principles of loom building. The same initiatory motions, defined as being necessary in weaving, obtain in the loom, but with very wide differences in mechanical principles.

Extraordinary as it may appear, hitherto small-ware looms have, as regards dimensions, been designed on similar lines to looms for weaving ordinary or wide fabrics. One leading idea of the inventor has been to obtain positive action in all the motive parts, and these to be under the control of one central grooved shaft. The loom has motions for throwing out of gear, on the discontinuance of either warp or weft threads, which, moreover, are applied to every single width of fabric, though any number of looms may be grouped together.

Treating of the motions seriatim, first, the shedding of the warp; this, as seen, is effected by two uprights fixed in opposite positions on the central shaft, and secured to the heddles, causing them to rise and fall alternately.

The picking is more ingenious. One of the chief defects of all modern power looms is a loose or flying shuttle, and the greater the width of the fabric, the greater this defect. The Poyser shuttle is held during its passage across the warp, the propeller on one side only releasing it, when the propeller on the opposite side engages.

Another noteworthy difference is in the position of the reed or sley. In the ordinary power loom the reed travels some inches from the cloth, to allow the shuttles to pass in front when the shed is formed in the warp. In this loom, however, the traverse of the reed is but a fraction of an inch, which increases the possibility of higher speed in weaving. It will be obvious that if the batten has only this moiety of movement, no shuttle to be of any service could run in front of the reed.

The temerity of the inventor is seen in his successful device for running—what had hitherto not been accomplished—a shuttle behind the reed, necessitating a division in the reed to allow the tongue or projection of the shuttle to place the thread of weft against the fell of the fabric. One advantage is that the shuttle places the weft almost in the exact position it is to occupy in the fabric, removing the friction upon the warp yarns produced in other looms, due to the backward and forward traverse of the reed for several inches to allow of the crossing of each shot of weft.

The let off of the warp and the take up of the fabric are, though different in type from those commonly used, as true in timing and in adjustment to each other as any which have been devised. The remarkable evenness of the fabric is the best indication of correctness of movement in these parts.

I will make only brief mention of the warp stop motion. It consists of passing the threads of warp under the hooked portion of what is termed the "dropper," a small metal plate. The loom is driven by clutch gearing, and on the breakage of a warp thread the dropper, through suitable connections, withdraws the clutch from action.

In this paper, it has only been feasible to deal with a very small portion of what may be claimed to be "recent inventions" in weaving machinery. No reference, for example, has been made to the improvements of Continental loom makers, particularly the German in heavy looms, and the Swiss and the French in looms for weaving silk and light fabrics. Some of these, which I had to adjudicate upon at the Paris Exhibition, might have been incorporated in this paper, but their diversity has rendered it necessary to leave the consideration of them to the future.

The question which must suggest itself to the textile machinist at the present time, is on what lines, old or new, is the loom to be constructed. Every student of weaving machinery recognises that, perfect as the loom is as a combination of mechanical parts—each series having its specific functions to perform, yet so co-ordinated that they work in unison with each other, resulting, not separately, but in combination, in the weaving of a fabric—that for whatever purpose the loom has been designed, the motions have very largely been developed from an idea on which mind after mind has laboured.

Apparently the motions in weaving are fixed for all time. Granting that the present types of mechanism are the best adapted fot the purposes for which they were designed, then the task of the machinist should be largely one of simplification.

What is needed is first, as suggested, simplicity of mechanism ; second, perfect manufacture, involving high engineering skill ; third, more capacity for design aud fabric structure, which alike render novelty and excellence possible, the qualities which the users of power looms have to depend upon for the sale of their productions.

[It has been found necessary to pospone the publication of the illustrations to this paper. The figures will be printed as a separate Supplement to the next number of the *Journal.*]

The American Northrop loom (made by the Draper Co., Ltd.), Hutchins's patent Swivel, and a new open shed Jacquard (made by the Knowles Co.), were lent by Messrs. Hutchinson, Hollingsworth and Co., Ltd., Dobcross ; the Poyser smallware looms by the Poyser Tape Loom Syndicate, and models of shuttle-changing motions by Messrs. Hattersley and Sons.

DISCUSSION.

Sir HENRY TRUEMAN WOOD asked whether the reader of the paper could hold out any prospects in connection with the commercial application of photography to weaving, a subject of which a good deal was heard a year or two ago. The process, as far as he could recall it, was a method of translating into a series of symbols the lights and shades of the ordinary half-tone photograph in such a way that a Jacquard card could be cut from the photographic pattern thus produced. He had been shown some very complicated patterns which had been woven by those means. If he remembered rightly, not only could complicated patterns in monochrome be produced, but, by the use of coloured screens in the way familiar to photographers, a Jacquard could be produced containing the necessary arrangement for weaving different colours. From the photographic standpoint, the system was extremely ingenious. It would be interesting if Mr. Beaumont could state whether the invention was used commercially.

Mr. J. S. AUSTEN said Mr. Beaumont had compared the Poyser loom with the narrow fabric loom, somewhat to the disadvantage of the latter. In looking at the machines, however, he had been struck with the fact that the Poyser loom would only make a single piece, whereas the ordinary loom made, perhaps, 50. It therefore appeared to him that 50 Poyser looms, in producing the same amoun of work, would take up five or six times the space a ordinary narrow fabric loom would occupy. He als thought the Poyser loom was an extremely complicated piece of mechanism.

The CHAIRMAN, in proposing a vote of thanks t Mr. Beaumont, said he did not think he had eve listened to a more lucid exposition of a subject of suc a complex and difficult nature. He was a little depressed at the commencement of the paper, t observe that some of the photographs of looms had German inscriptions underneath them, but he was subsequently relieved to find that examples of the English machines were exhibited He was also depressed by Mr. Beaumont's statement that some remarkable new departures in th mechanism of textile machinery, which had been invented by Englishmen, had not been appreciated by the conservative English manufacturers. As a member of the Technical Education Board of th London County Council, he had lately heard a good deal of evidence from gentlemen occupying high scientific positions, and others who were practically engaged in industrial pursuits, with regard t the possibility of bringing to bear new and improved methods of education with a view to increasing th industrial efficacy of the country. It was the opinion of these very eminent gentlemen that the present industrial condition of the country was due not so much to the deficiency of the educational system (very great strides having been made in the improvement of educational methods of late years, though deficiencies still existed), but to the indisposition of manufacturers to recognise the new developments which occurred in industry. He did not believe there were better schools to be found than the Engineering Schools of the Central Technical College of the City Guilds, King's College, and University College, the equipment and the eminent professors who treated on engineering in those establishments, leaving nothing to be desired, even when placed in juxta-position with the great educational institutions in Germany, which were so often quoted. The schools complained that even when competently trained and equipped young men were turned out the manufacturers did not appreciate them. The great firms in Germany had at their disposal bands of young men trained in the polytechnics of the country, and utilised their knowledge not only in connection with the practical conduct of their works, but in experimental research relating to the improvement of the industry. In that way Germany had gone ahead. It was a lamentable condition of things that English manufacturers were so conservative that they would not utilise the improved training of the youth of the country in industrial pursuits. The dyeing of colours with aniline was originally conceived in this country 30 or 40 years ago, but, unfortunately, the whole of that industry was now centred in Germany. Lord Rosebery's recent speech in Glasgow ought to have roused the English manufacturer to the dangerous position he now occupied, and he hoped the similar note of alarm sounded by the reader of the paper would have the effect of waking the country up to he danger which undoubtedly was underlying its ndustrial interests.

Mr. R. F. **Moore** (Master of the Clothworkers' Company) seconded the motion.

Professor **Beaumont**, in reply, after thanking the members for the vote of thanks, said that on the Continent there were two installations commercially working the Szczepanik system of reproduction of photographic designs. In the first place, a series of negatives were made from an artist's sketch, the design being then developed negative by negative. Supposing, for example, there were three spaces of different shapes, angular, circular, and square: they formed one figure or design. A negative would be taken of each of those divisions of the design, and thrown on to the large sheet of paper, on which the design had to be produced for the loom. Then, by the use of divisional sections, that large sheet of paper, which was nothing but a photographic reprint, was divided into small sections. It would be understood that there must be some theoretical form in which the designer could conceive a pattern; and that theoretical form was on ruled paper, each division in the paper representing one warp thread or one shot of weft in the loom. It was in the dividing of that paper, in accordance with the standard system, that one portion of the ingenuity of the Szczepanik process came in. The inventor had succeeded, in addition, in applying to the various sections of the pattern what were known as the weave elements or weave units. In setting up a sheet of paper with type there were so many distinct ypes making so many letters, with different syllables; and, in designing for the loom, there were different weave units corresponding to the alphabet and to syllables, of which words were composed. The system was such that any distinct weave unit could be applied o any portion of the fabric. On looking at a linen able cover it would be observed that it was perfectly white, and yet there was a figure or design developed on its surface, that being due to the change of the weave units. If the fabric were analysed it would be found that wherever there was a change in effect in he development of design there had also been a hange in the interlacing of the warp and weft. He was not able to advance any definite opinion as to whether the invention was of commercial value at resent. He had not seen the apparatus for more han twelve months; and although some of the designs produced were perfect and weaveable, and ould be transferred direct to the Jacquard loom, he id not think the idea had been taken up with much nthusiasm on the continent. From the practical way in which Mr. Austen had tackled the subject, he almost hought that gentleman must have had some knowledge of weaving. Mr. Austen's views were those held by practical men, but they were not altogether sound. The Poyser loom only occupied a fraction of space from front to back, and height, compared with the ordinary loom. Each head was a loom, which necessarily meant that if forty widths of tape or ribbon were being produced, forty Poyser looms would occupy more space lengthways than an ordinary loom producing an equal number of tapes. But that did not prove that the Poyser loom could not be built on the ordinary principle. He had seen a drawing which had been prepared for constructing the Poyser loom in such a manner that there would be groups of 5, 6, or 10, as the manufacturer might think proper. The Poyser loom being complete in each head, if anything went wrong in the weaving of of one width of tape only, that head was arrested. In the Paris Exhibition, a loom was shown weaving about sixty widths of narrow fabric, and in watching the machine at work, he noticed that if one warp thread broke in any one of the sixty widths the whole of the loom had to remain inoperative while that one width of warp was being linked together, involving an enormous loss of time. The Poyser loom was ideal in the respect that when anything went wrong with one width of fabric the other 80 or 100 could still continue in operation. He had been interested in the Chairman's remarks in reference to education, in relation to industrial progress. He was familiar with what was done on the Continent and in the States, and the difficulties mentioned by the Chairman were shared by himself. It was not that the young men were not trained or that the foundation was not deeper and wider than that which could be attained by the apprenticeship system or in the workshop; it was not that the young men had not been a success when they had had an opportunity of entering the mill; but it was the large amount of prejudice existing amongst the industrial employers which had to be removed. The notion was abroad that if science was being taught, the professor was simply teaching the theory, and that the theory was simply incapacitating the young man for the practise; whereas it had ever been the endeavour of the Clothworkers' Department of the Yorkshire College, and also of other textile schools in the country, to supplement the teaching of the science by experiments of a research nature which would be as practical as possible in the factory. He could quote many instances of manufacturers who, although originally adverse to technical education, when they had seen the work accomplished by a student whom they thought to be a mere theorist, in his advanced year of study, had said they would employ that student if he were satisfactory in other respects. If those who were responsible for the development of the teaching would but introduce into all their work the very best ideas that could be gleaned from abroad and at home, the real success of their industrial system of training would be seen in the future development and extension of their industries.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 5.—"Sound Signals." By E. PRICE EDWARDS. LORD RAYLEIGH, D.C.L., LL.D., F.R.S., will preside.

MARCH 12.—"The Utility of Alkaline Phosphatic Manures." By JOHN HUGHES, F.I.C. PROFESSOR HENRY E. ARMSTRONG, L.L.D., F.R.S. will preside.

MARCH 19.—"Electric Traction. London's Tubes, Trams and Trains." By J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E.

⁂ Prof. Thompson's paper previously announced for this date will be read at a meeting after Easter.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By THOMAS WILLIAM HOLDERNESS, C.S.I. SIR ANTONY PATRICK MACDONNELL, G.C.S.I., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

MARCH 4. 8 p.m.—"Structural Colour Decoration of the Interior of Public Buildings." By GERALD C. HORSLEY. WALTER CRANE, A.R.W.S., will preside.

CANTOR LECTURES.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.

March 3, 10, 17.

LECTURE I.—MARCH 3.—General description of photo-mechanical printing processes—Light action on compounds of gelatine and bichromites—Description of the working of the photo-lithographic process and its applications—Methods of preparing typographic blocks by the line and half-tone processes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. D. Geddes, "Photography as Applied to Illustration and Printing." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Orlebar, "Local Agricultural Societies."

Royal Institution, Albemarle-street W., 5 p.m.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Benjamin H. Thwaite, "British versus American Patent Law Practice and Engineering Invention."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. F. R. O'Shaugnessy, "Birmingham Sewage." 2. Mr. E. G. Clayton, "Technical Examination of Glue."

Imperial Institute, South Kensington, 8½ p.m. Mr. Edward Wakefield, "New Zealand."

British Architects, 9, Conduit-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Dr. Lockyer, "Some Uses for Hand Cameras."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. J. M. Maclaren, "New Zealand Fjords."

TUESDAY, MARCH 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Gerald C. Horsley, "Structural Colour Decoration of the Interior of Public Buildings."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. N. Shaw, "The Temperature of the Atmosphere." (Lecture II.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by Messrs. W. M. Mordey and Bernard M. Jenkin, "Electrical Traction on Railways."

Imperial Institute, S.W., 4½ p.m. Mr. R. H. Wallace, "Our Crown Colonies." (Lecture I.)

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. N. Buxton, Photographs of Animal-life in the Egyptian Soudan. 2. Dr. H. L. Jameson, "The Origin of Pearls." 3. Dr. R. Broom, "The Organ of Jacobson in the Elephant-Shrew."

WEDNESDAY, MARCH 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Mr. E. Price Edwards, "Sound Signals."

Archæological Institute, 20, Hanover-square, W., 4 p.m. 1. Prof. T. McKenny Hughes, "Early Potters' Art in Britain." 2. Mr. F. G. Hilton Price, "Pawnbrokers' Signs in London."

Entomological, 11, Chandos-street, W., 8 p.m.

Archæological Assoc., 32, Sackville-street, W. 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MARCH 6...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. A. Gruvel, "New Species of Lepadidæ." 2. Dr. G. Elliott-Smith, "Morphology of the Brain in Mammalia."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. Bone and Wheeler, "The slow oxidation of methane." 2. Mr. F. R. Francis, "Isomeric additive compounds of dibenzyl ketone and deoxybenzoin with benzal-p-toluidine, m-nitrobenzalaniline and benzal-m-nitrailine." (Part III.) 3. Messrs. Fenton and Ryffel, "Mesoxalic semi-aldehyde." 4. Messrs. Forster and Micklethwait, "m-Nitrobenzoylcamphor." 5. Mr. J. C. Crocker, "Picrimidothiocarbonic esters."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Henry Craik, "Scotland's Contributions to the Empire." (Lecture II.)

Civil and Mech. Eng., St. Ermin's Hotel, Caxton-st., S.W., 8 p.m. Mr. N. G. Gedge, "The Causes and the Prevention of the Erosion of Sea Coasts."

FRIDAY, MARCH 7...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. H. Becquerel, "Radio-Active Bodies." (In French.)

Geologists, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

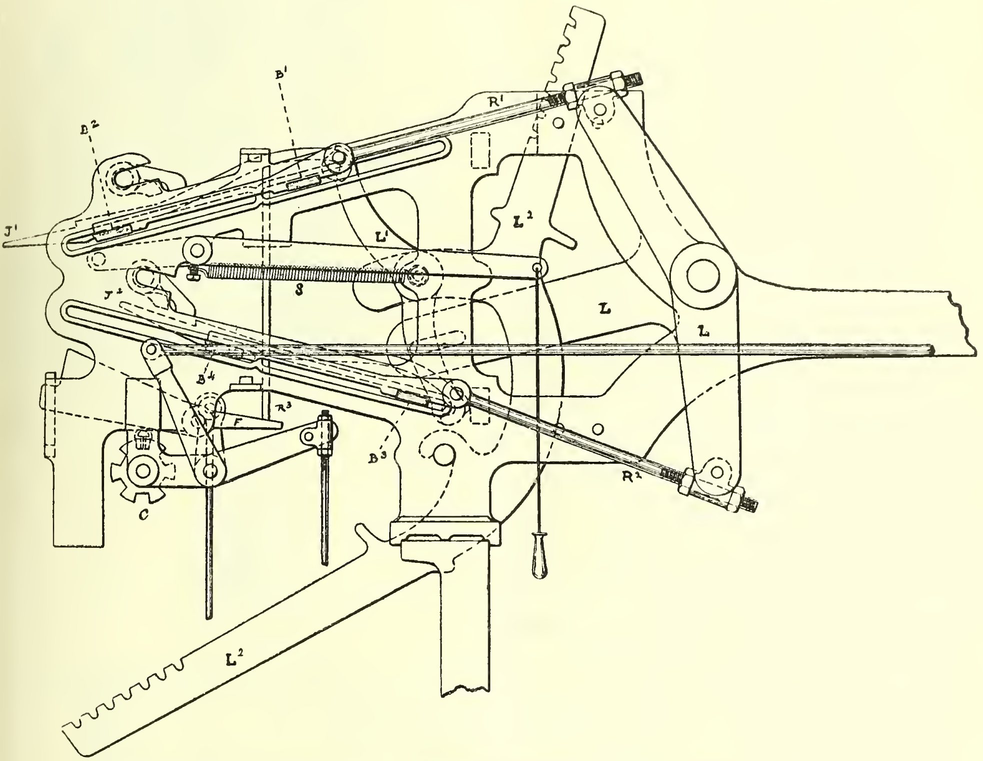
Quekett, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MARCH 8...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Some Electrical Developments." (Lecture IV.)

ILLUSTRATIONS TO PROFESSOR ROBERTS BEAUMONT'S PAPER ON "RECENT INVENTIONS IN WEAVING MACHINERY."

(See *ante*, February 28, 1902, p. 301.)

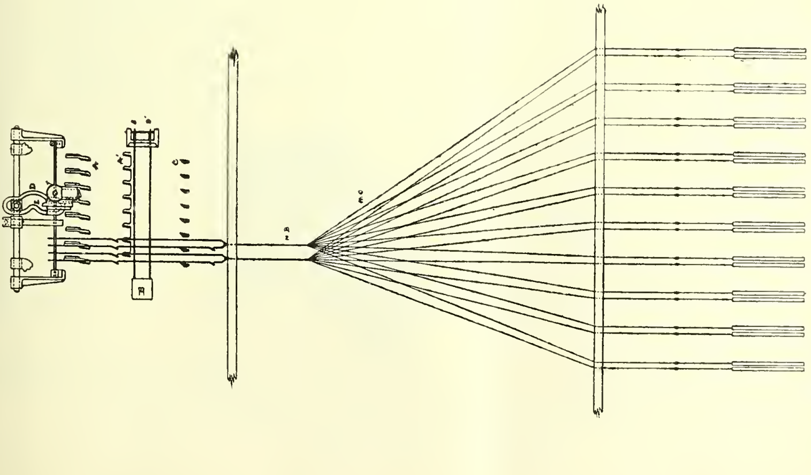
FIG. 1.



KEIGHLEY ANGLE DOBBIE. Made by Messrs. Geo. Hattersley and Sons, Ltd.

The dobbie is of the open shed type. B¹ to B⁴, lifting bars; J¹, J², engaging jacks; L¹, connecting lever for jacks; L², connecting lever for heddles of heald shaft; C, lag cylinder; F, indicating finger.

FIG. 2.



OPEN SHED JACQUARD. Invented by Stafford and Kelmel, and made by Messrs. Knowles and Co., U.S.A.

A, A¹, lifting bars; B, holding-up bars; C, cylinder; D, eccentric groove; S, springs for needles or cross wires; N, B, neck bands; H, C, harness cords.

Fig. 3.

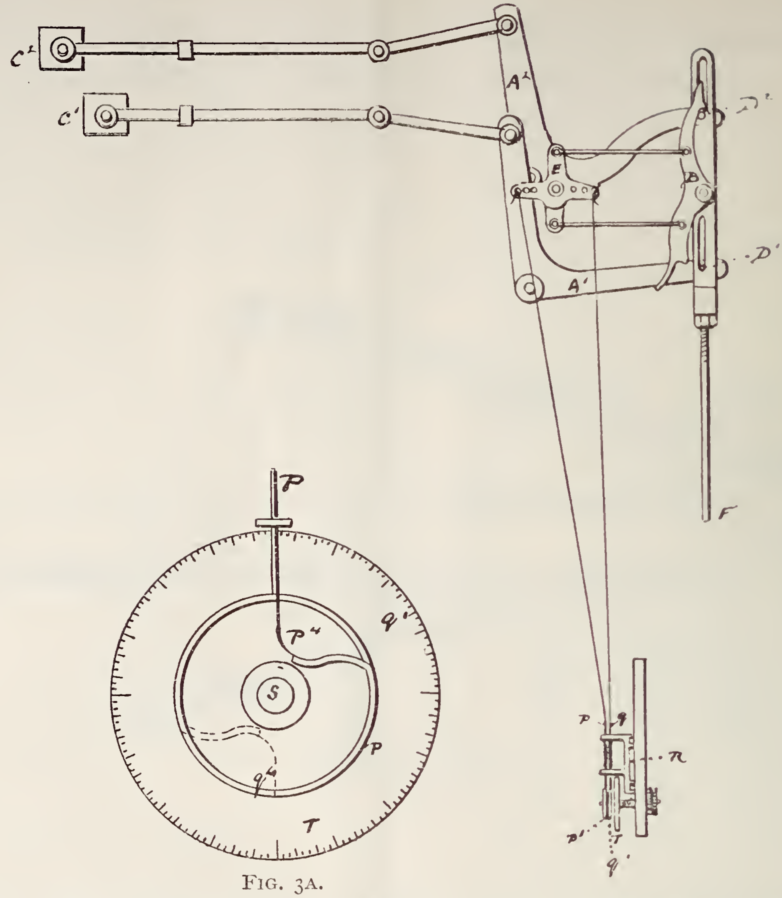


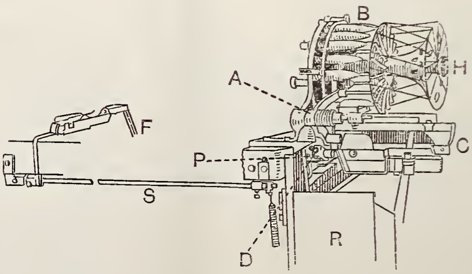
Fig. 3a.

Fig. 3.—Multi-Cylinder Jacquard. Paton's Invention, and made by Messrs Hutchinson, Hollingsworth and Co., Ltd.

C¹, C², cylinders; A¹, A², elbow lever; B, duplicate catch; D, D¹, pins of levers, A¹, A².

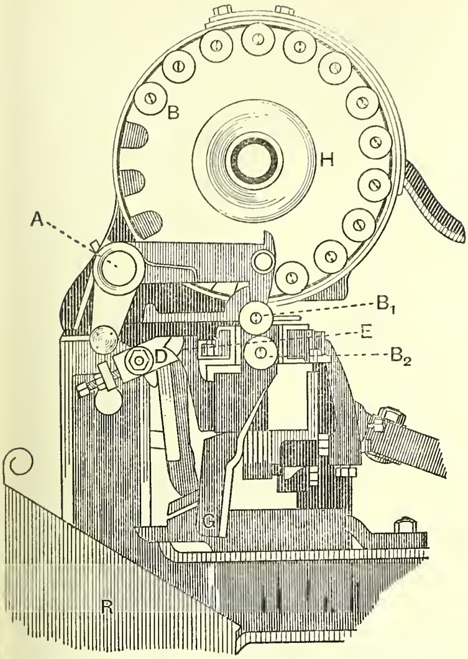
Fig. 3a.—Registering Scale for determining the Length of Fabric to be woven FRO Cards on either Cylinder, C¹ or C².

Fig. 4.



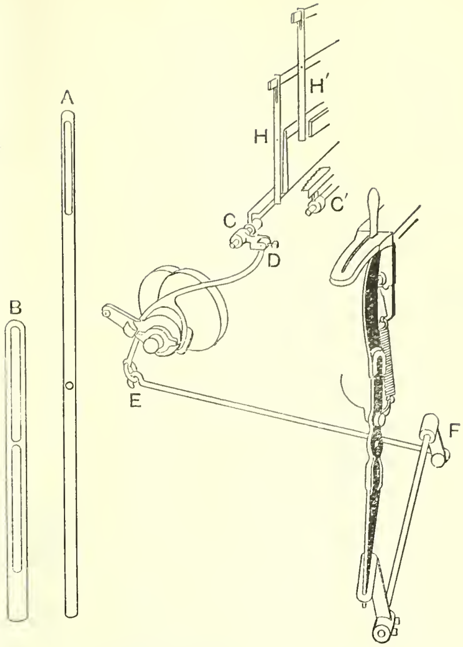
Northrop Automatic Shuttle Filling Invention. (Front view.)

Fig. 5.



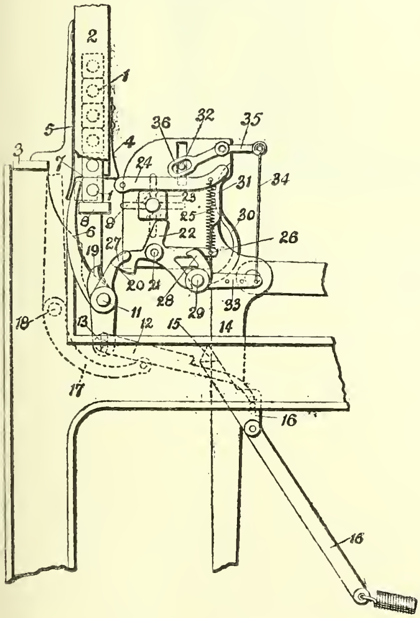
Northrop Automatic Shuttle Filling Invention. (End view.)

Fig. 6.



Northrop Warp-Stop Motion.

Fig. 7.



Details of Hodgson's Patent Shuttle Changing Motion.

Fig. 8

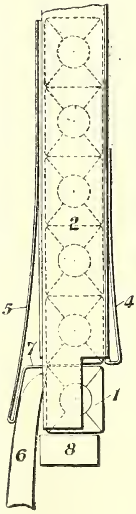
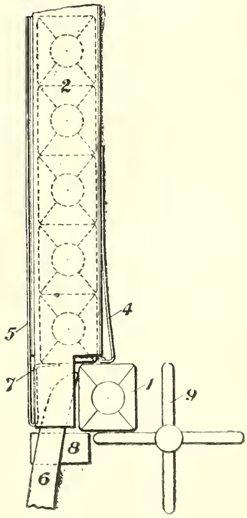


Fig. 9.



Shuttle Receivers and Action of Finger, 6, in transferring the Shuttle from the Receiver to the Conveyer, 9.

FIG. 10A.

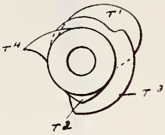


FIG. 11.

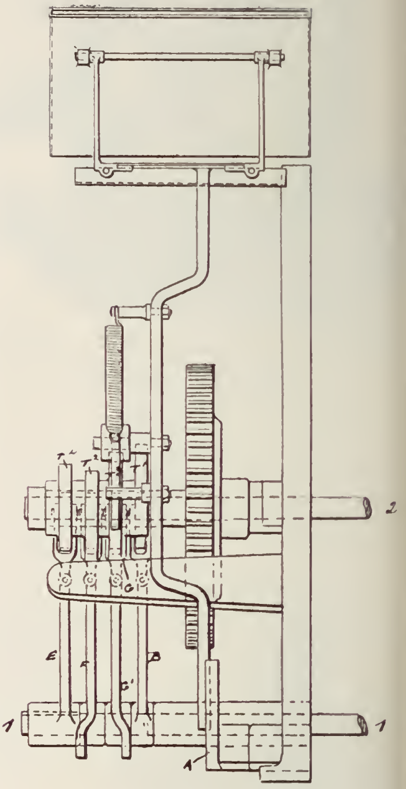


FIG. 10.

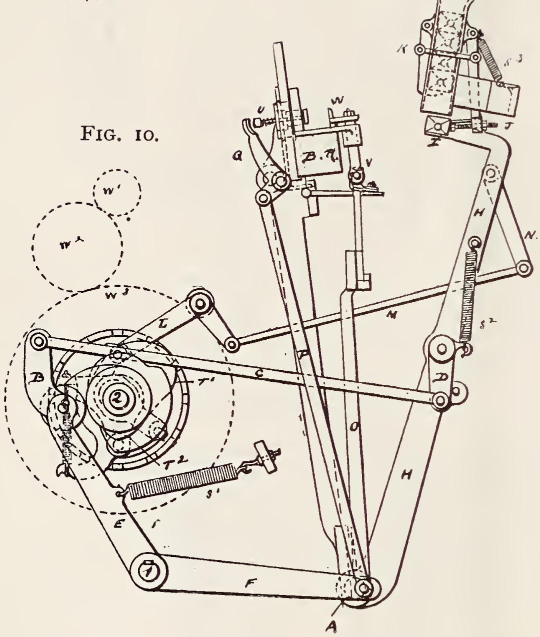
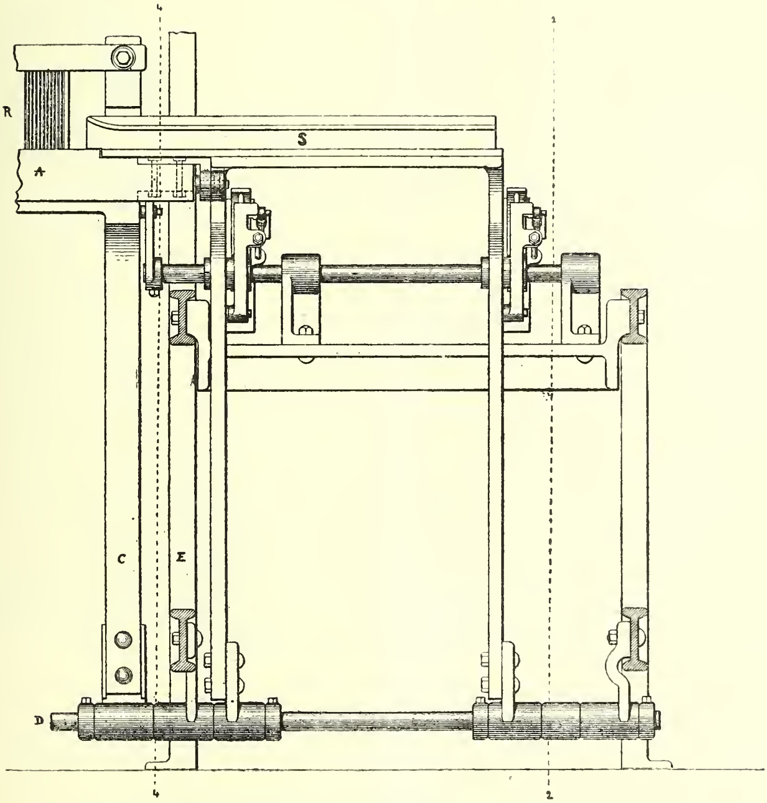


FIG. 10.—HATTERSLEY'S INVENTION FOR SHUTTLE CHANGING, SHOWING THE TAPPETS AND LEVER Z-CONNECTIONS.

FIG. 11.—END VIEW OF HATTERSLEY'S SHUTTLE-CHANGING MOTION.

Fig. 12.



Hollingsworth's Invention for Disconnecting the Shuttle Boxes and Lathe carrying the Reed.

Fig 13.

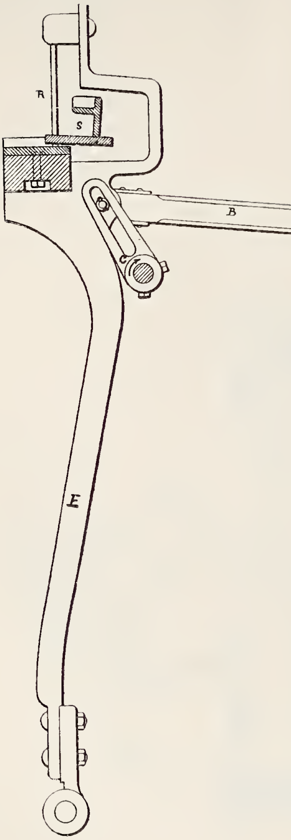
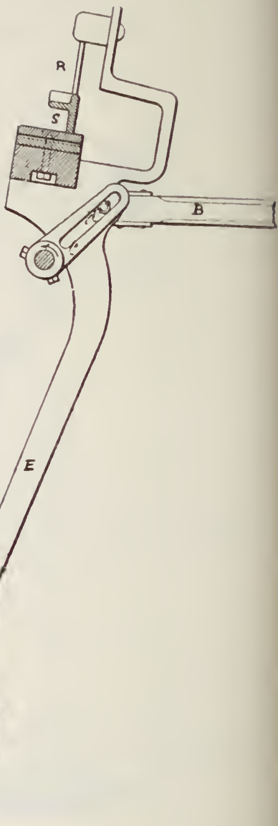


Fig. 13A.



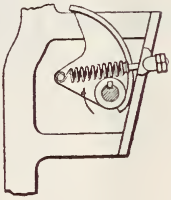


Fig. 13B

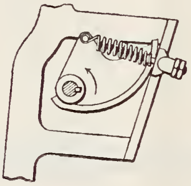


Fig. 13C.

Figs. 13, 13A.—Showing the position of the Crank, B, with the Reed connected, and partially disconnected respectively.

Figs. 13B, 13C.—Relative Positions of the Cams.

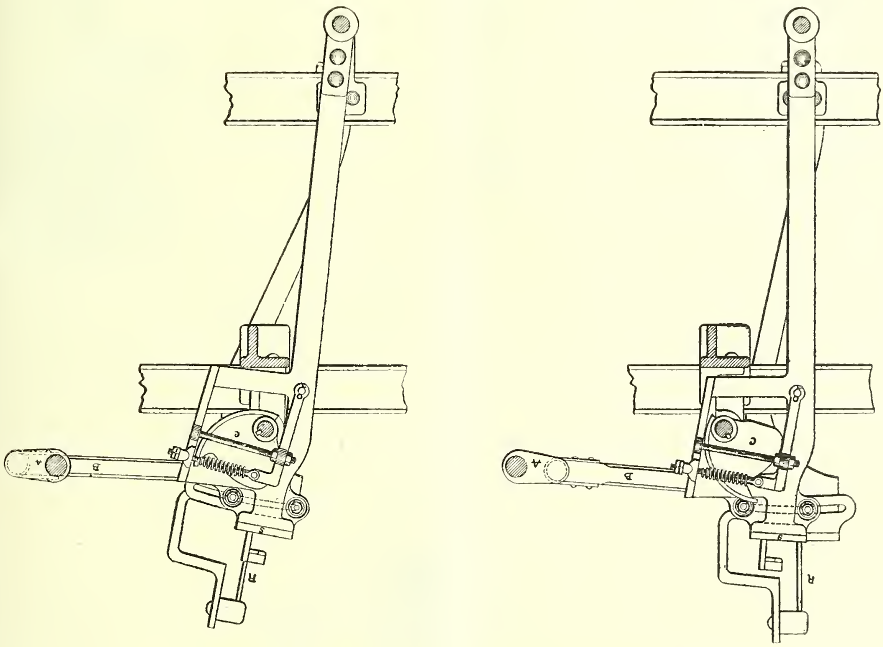


FIG. 14.

FIG. 14A.

RELATIVE POSITIONS OF CAM, C, AND CRANK, A.

Fig. 15. Fig. 16. Fig. 17. Fig. 17a.

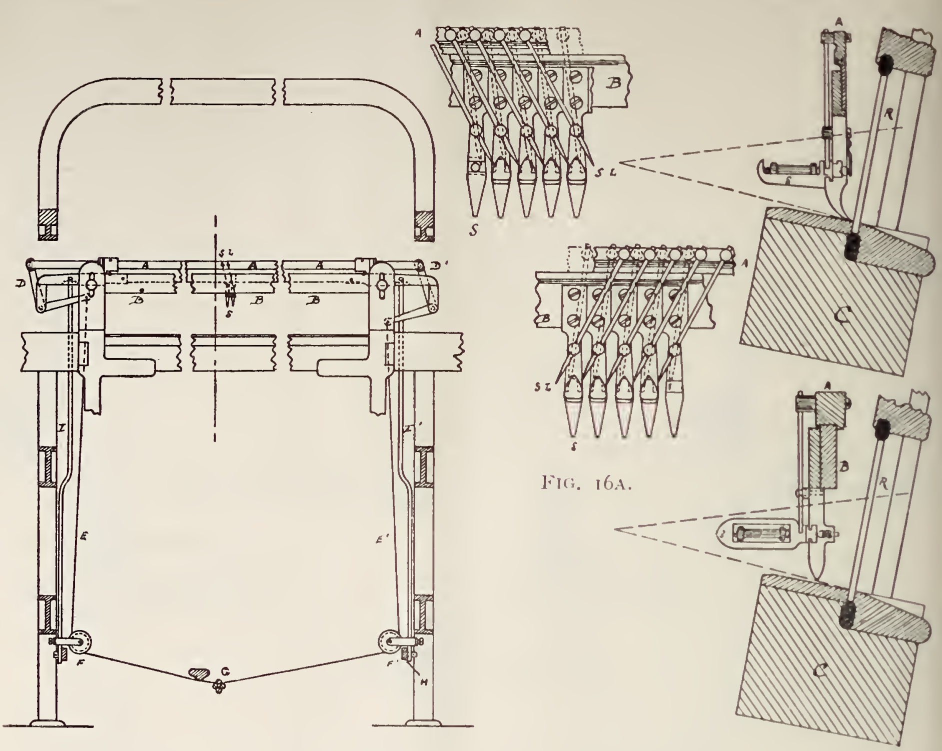
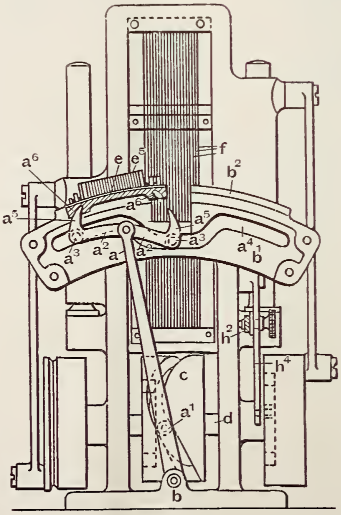


Fig. 16a.

Details of Hutchins New Swivel Loom.

Fig. 18.



Front view of Poyser Small-Ware Loom.

A^6, shuttle; A^3, groove for shuttle propeller; C, grooved roller, which imparts motion to the upright carrier; H^1, wheel for actuating the heald shaft frame.

Journal of the Society of Arts,

No. 2,572. Vol. L.

FRIDAY, MARCH 7, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, March 10, 8 p.m. (Cantor Lecture.) J. D. Geddes, "Photography Applied to Illustration and Printing." (Lecture II.)

Wednesday, March 12, 8 p.m. (Ordinary Meeting.) John Hughes, F.I.C., "The Utility of Alkaline Phosphatic Manures."

Thursday, March 13, 4.30 p.m. (Indian Section.) Thomas William Holderness, C.S.I. (Secretary, Revenue Department, India Office), "The Indian Famine of 1899, and the Measures taken to Meet it."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 3rd inst., Mr. J. D. Geddes delivered the first lecture of his course on "Photography Applied to Illustration and Printing."

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, March 4, 1902; Walter Crane, A.R.W.S., in the chair.

The paper read was on "Structural Colour Decoration of the Interior of Public Buildings," by Gerald C. Horsley.

The paper and report of the discussion will be printed in a future number of the *Journal.*

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1902 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 5th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry —the utilisation of waste silk."

In 1887, to Her Majesty Queen Victoria, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "fo his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previousl worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O. K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of th manner in which he has promoted several importan classes of the Arts and Manufactures, by the applicatio of Chemical Science, and especially by his researche in the manufacture of iron and of steel; and also i acknowledgment of the great services he has rendere to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (now Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery being generally promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce, by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics; researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small, a discovery now used in all dynamo machines; and for its application to the production of the electric search-light, and to the electro-deposition of metals from their solutions."

In 1901, to His Majesty the King, "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

Proceedings of the Society.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 5th, 1902; The Right Hon. Lord Rayleigh, D.C.L., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bell, Colonel A. W. C., West End-house, Witney, Oxon.
Gilchrist, William, Cringletie, Peebles, Scotland.
Shingleton, Albert James, 8, Argyll-mansions, West Kensington, W.
Smith, John Ciceri, 61, Hatton-garden, E.C.
Thomson, H. Arthur, A.I.E.E., 45, North Bridge-street, Airdrie, Scotland.

The following members were balloted for, and duly elected members of the Society:—

Hunter, Summers, M.I.N.A., North-Eastern Marine Engineering Co., Ltd., Wallsend, Newcastle-on-Tyne.
Page, Davidge, A.I.E.E.. Hotel Russell, Russell-square, W.C.
Apostoloff, Serge B., 28, Bush-lane, E.C., and Victoria-square, Grosvenor-gardens, S.W.
Finzi, John Abraham, 53, Hamilton-terrace, N.W.

The paper read was—

SOUND SIGNALS.

By E. Price-Edwards.

Navigation near to land is acknowleged to be more difficult and dangerous than in mid-ocean. Out in the open expanse with plenty of sea room, a capable commander, with a good ship, is much more easy in his mind even when the wind blows a gale and the waves run mountains high, than if he were near the coast among the narrow channels, the rocks and shoals, the lee shores, which threaten him on all sides. From the earliest period of navigation efforts have been made to set up marks and signs of the sea whereby the mariner might be assisted to work his vessel safely through the fringe of danger round the coast. In those old times castles, church steeples, towers, clumps of trees, and other prominent objects on the mainland offered themselves, and were used by seamen as guiding marks by day, and here and there a blazing fire was shown from a tower in the night time. Since those ancient days the condition of things as regards navigation has completely changed, and to-day the waters adjacent to the sea coasts in every part of the globe are traversed by vessels of all kinds, from the steam and sailing leviathans that carry on the maritime trade of all nations, to the small coasters that perform the local shipping service. To serve this enormous traffic, to help to safeguard the thousands of precious lives and the untold wealth of the commodities carried on board these innumerable ships, elaborate and costly lighthouses are set up which by night send forth powerful beams of light; lightships are moored in positions where by day they are like sentinels in the sea, and by night their flashing rays sweep the surrounding waters; thousands of floating buoys of various shapes, sizes and colour (of late years many of them illuminated by means of compressed gas stored up in their bodies) are placed to define the navigable channels, or to mark the near position of hidden dangers.

The Need for Coast Fog Signals.

In ordinary conditions of the atmosphere these numerous landmarks and sea marks render invaluable service to the vast array of ships that pass through coastal waters. But when fog settles down on the face of the sea the lighthouse stars of the first magnitude, the friendly rays of the lightship's revolving beams, the crowd of bobbing buoys with their winking lights, are all overwhelmed and rendered useless. Nothing is visible but fog; the perils of sea voyaging are greatly increased, and the captain is left alone with his compass, chart, and lead to make his way as best he can.

At such a time the mariner, with strained attention, can only grope his way slowly through the vague unknown, in anxious dread of getting out of his course, of stranding on a sandbank, or striking a rock, or of colliding with another vessel. In order to afford aid to mariners under such conditions, it was necessary to bring into operation some system whereby warning or guiding signals might be effectively conveyed to a befogged shipmaster which should tell him where he is and help him on his way, and up to modern times it has been found that sound is the only medium which can be made practically serviceable for this purpose. Therefore, earnest consideration has for many years past been given to the production of noise-making instruments of great power, capable of being heard at a serviceable distance. Most people will agree that in ordinary everyday life, especially in the large towns, there is already too much noise, and it may be thought that those who devote themselves to the production of the loudest and most penetrating sounds do not earn the gratitude of the bulk of their fellow creatures. Indeed it may be remarked in passing that most of us would be better in health, happier in existence, and better tempered if the screeching of whistles, banging of doors, blowing off steam, and the eternal roar and rumble in our streets were altogether abolished. But the preceding remarks will show that there are occasions and conditions when noise making is raised almost to a fine art, and every effort is exerted to produce the most distinctive, the loudest, and probably most disagreeable sounds that can be developed. It is concerning these efforts as made by the lighthouse authorities of this and other countries that I have to address you this evening, and in doing so I must ask your patience, for the subject, though interesting enough to those connected with its practical application, has a tendency to be rather dry and tedious when brought to the notice of those who are not directly concerned with its working and development.

Experiments of 1874.

Twenty years ago I had the honour to address an audience in this hall on this same subject, and was then able to tell the story of some very important experiments which had been carried out in 1874-5 under the auspices of the Trinity House Corporation with the invaluable aid of Professor Tyndall, who was at the time the scientific adviser to the Corporation.

Passage of Sound in Fog.

It was then demonstrated that, contrary to the generally received opinions, a condition of fog was not unfavourable to the passage of sound through the air—a most important consideration, because it showed that at the special time when no other form of signalling was available, sound could be used and would give its best effects, and also that results of experimental trials made in clear weather would be borne out and probably enhanced in foggy weather.

ACOUSTIC CLOUDS.

The theory of acoustic clouds in the atmosphere acting prejudicially on the propagation of sound in the atmosphere was also promulgated by Professor Tyndall. Such clouds are said to be formed by air currents of varying temperature or vapour saturation, and the sound waves encountering these areas of different density are said to be reflected and re-reflected so that their energy is dissipated and lost. This theory, though most ingenious, does not appear to have met with unanimous acceptance in scientific circles, and doubts still exist whether it affords a true explanation of certain phenomena in regard to the disappearance of sound in fine, clear, and calm weather, which had been experienced during the South Foreland trials. But, however that may be, it does not materially affect the question of sending sound through fog, because, as a general rule, when fog prevails the temperature and saturation of the air are uniform over the foggy area, and the homogeneous condition so established is not favourable to the formation of acoustic clouds.

SOUND SHADOW.

Among other observed facts concerning the propagation of sound, which were brought to notice in the trials of 1874, it was shewn that sound proceeding from an instrument set up on the coast may be seriously interfered with by projecting points of land, whereby an area of sound shadow may be formed beyond. Also that a somewhat similar effect was liable to be produced by sound waves striking the face of a neighbouring cliff, the reflected waves so produced, if out of step with the direct waves, setting up such interference as to cause the direct sound to be greatly enfeebled, or even at times extinguished.

EFFECT OF WIND.

The general belief as regards the obstructive action of wind when blowing in a direction opposed to that in which the sound is projected was fully confirmed, it being recognised that an adverse wind of a certain force was fatal to the most powerful sound-producing instrument then known. As a result of this experience, Professor Tyndall expressed the opinion that no signal could be relied upon to be heard at all times and under all conditions of weather for a greater distance than from two to three miles.

INSTRUMENTS IN USE.

Bells. — As regards instruments for producing sound which were in use at that time for signalling purposes, I may mention that bells of between three and four cwt. were fitted at most lighthouses. The striking was effected by a clockwork arrangement, and the sound emitted seemed very powerful to an observer in close proximity to the bell, but its effective sound range was exceedingly limited, for bell sounds are wafted about by every zephyr that blows. In most cases the bells remain at the lighthouses to be made use of in foggy weather if no other more powerful sound producer is at the station.

Gongs.—The gong was formerly used as the special kind of fog signal for a lightship, but the weakness of its sound and failure of penetrating power, have caused it to be superseded by other instruments.

Whistles.—Neither steam nor air whistles appear to have found much favour in this country. On the coasts of the United States they were and are still employed for fog signal purposes, and various examples were tested in the experiments of 1874, but they were regarded as wasteful instruments requiring about 70 lbs. pressure of steam, and their performance does not seem to have made a favourable impression on British ears, and the siren has proved to be a much more efficient instrument.

Guns.—The explosion of a 3 lb. charge of gunpowder at the mouth of a gun has been frequently admitted to be a useful form of sound signal, and has been in practical service at various stations for many years. Its drawbacks have been stated to be that the duration of the sound is so short that it is liable to be obliterated by a local noise, or quenched by an opposing wind at a very short distance. In the trials at South Foreland two kinds of gun were included, viz., the long 18-pounder and a short howitzer.

Reed Horns.—When the experiments of 1874 were set on foot there had been in operation for a few years a reed-horn sounded with air compressed by Ericcson's hot-air engines, the whole fog signal apparatus being patented by a Mr. C. L. Dobell, of New York. Types of this instrument were tried at South Foreland.

Siren.—As the result of a visit of a Trinity House Committee to the United States in 1872, arrangements were made whereby a new instrument called a "siren" made from the design of Mr. A. F. Brown, of New York, should be sent for trial to this country, and it was included in the South Foreland experiments. To the principle of this instrument I shall refer further on.

RESULTS OF 1874 TRIALS.

Speaking generally in reference to the instruments tested in 1874, it may be said that the siren clearly demonstrated its superiority over all the other sound-producers with which it was compared as regards loudness and penetration, as well as the power of overcoming opposing influences, and that in consequence the siren principle has since been adopted for the large majority of coast fog signals set up on the British coasts, as well as for those on the coasts of France and other European countries, while in the United States its employment has been very considerably extended.

CHANGES SINCE 1874.

The foregoing abstract indicates the position of the fog signal question at the conclusion of the experiments of 1874. Since that period various changes and developments of more or less importance have occurred in connection with the instruments employed. Mechanical changes, of which I shall presently speak further, were made in the form of the siren; instead of direct steam, compressed air was used for sounding it, caloric engines, and more recently gas and petroleum engines, being used for compressing the air. A new method had been brought into use of differentiating sound signals one from another by means of combinations of high and low pitched notes, whereby the mariner should, on hearing a coast fog-signal, be able more readily to determine which particular station it came from. In this method the direct contrast of high and low pitched notes occurred in each signal, and by the use of a maximum of four sounds in one signal it was possible to obtain upwards of twenty serviceable distinctions.

As regards the use of guns for producing explosive sounds, the introduction of gun-cotton had displaced several of the gun signals, with their 3 lb. charges of gunpowder. It was found that the explosion of 4 oz. of gun-cotton in the open yielded quite as loud a noise as, and one of greater sharpness and intensity than, the discharge of 3 lbs. of gunpowder from a gun, and also that this effect could be produced with a much less expenditure of labour. In the first practical use of the explosive a 4 oz. charge was carried up by means of a rocket to a height of about 600 feet, and there detonated; but more recently the charge has been suspended from the end of a long jib, and exploded by means of a small dynamo operated by the keeper in the lantern of the lighthouse. The value of this form of sound signal is that it can be used at a lighthouse standing on a rock out at sea, where it would not be possible to place and work the machinery necessary for sounding a siren fog signal. For some positions, as at Flamborough Head, the rocket system is regarded as more suitable than the jib arrangement, in causing the explosion to take place at a height where its sound is free from local interferences, and so far removed from the lighthouse and buildings as to cause little or no inconvenience or risk. On the other hand the jib system does away with the rocket and its tail of fire, as well as uncertainty attending its flight, and enables the signal to be fired with greater ease and precision by the attendant.

An improvement in the form of the siren trumpet has been adopted for use on board lightships. Instead of having a bent head (to be turned in any horizontal direction required), the vertical trumpet was mounted with what has been called the mushroom head, designed to distribute the issuing sound in a horizontal direction equally all round the circle. The arrangement is that an inverted cone is fixed just above the open mouth of a vertical conical trumpet, and the sound issuing from the trumpet strikes the curved sides of the cone and is reflected out all round in the direction of the sea horizon.

MATTERS REQUIRING EXPERIMENTAL TEST IN 1901.

This, I think, sufficiently indicates the changes and supposed improvements which had been brought about since the experiments of 1874 — changes justified, no doubt, on theoretic grounds, but requiring, it was thought, the seal of experimental test. Other questions also had arisen requiring such test, viz., in regard to the relative efficiency of high and low notes; the most effective method of covering a sea area with a warning sound, whether by one large instrument with trumpet pointed against the wind, or with two smaller instruments and trumpets fixed at a suitable angle to embrace the whole arc to be guarded; the relative merits as sound producers and fog signals of the siren and the reed horn as most recently developed; the value of a new form of disc siren, and some novel forms of trumpet as designed by Lord Rayleigh. It was also desired to make some further observations in reference to the distribution and penetration of sound through the atmosphere, having regard to some anomalous occurrences which had been experienced in connection with some established coast fog signals.

Accordingly the Elder Brethren of the Trinity House, as the principal lighthouse authority, with the co-operation of the authorities for Scotland and Ireland (who have set up sound signals round our coast), arranged for a series of trials to be carried out at the fog signal station attached to the electric light establishment at St. Catherine's Point in the Isle of Wight, where there was in operation a first-class siren, and where steam power was available. A Special Committee of the Board was appointed with the Deputy-Master of the Trinity House as Chairman, the Committee having also the invaluable assistance and advice of Lord Rayleigh, and of Mr. T. Matthews, the engineer-in-chief to the Corporation. The locality chosen, as will be seen by the chart, afforded ample scope for making observations at sea at any required distance over a wide area of 280° in arc, and the Trinity House steamer *Irene* was detailed for conveying the observers from point to point as desired. On the 8th May last the actual trials and observations were commenced and were carried on day by day in a practically continuous manner until the 13th June, the observations being made in a systematic manner by each observer on cards specially prepared for the purpose. No less than 4,600 observations were thus recorded, which were afterwards carefully tabulated and summarised, and the results obtained by this process were found to be quite in accordance with the general opinions formed by this observing Committee.

It is proper here to state that before entering upon their investigation, the Committee considered whether they should include trials of schemes for conveying signals to a befogged mariner by other means than sound. Several projects to be actuated by electrical methods were proposed for trial, including the apparatus of Mr. Marconi, and other inventors or patentees, for establishing communication by means of etheric vibrations. Reference was also made to a plan for transmitting electric impulses from shore through a submarine cable, which within a certain area in the vicinity of the cable would induce responsive electrical impulses in a suitable receiver on board a vessel coming within such an area. But it did not appear that these projects were in such a condition of development as to enable them at once to be subjected to practical trial in connection with the objects of the inquiry; it was also thought that merely tentative experiments in regard to the possibilities of the schemes would occupy a very considerable length of time, and necessitate a correspondingly large outlay, with the possible result that they might after all prove of no real service. Of course it is greatly to be desired that some method of this kind may in course of time be successfully made available for conveying warnings in foggy weather, for it would possess the great advantage of being independent of the capricious influences of the atmosphere, but it may be well for a moment to consider one or two points in this connection which may not be generally apprehended. The real value of a sound signal to a mariner in a fog at sea is that on hearing it he can form a fairly approximate idea of the direction from which it comes, and is thus able to keep away from it. In the case of etheric vibrations a received message may indicate the name of the station from which it proceeds, but where that station is situated relatively to the receiver, the message gives no information whatever; it can only be said to come from the circumambient space. Again, a sound signal will give him some general idea of his distance from the station say within 10 miles, but an etheric message may come to him from any distance, without giving him any idea of how far he is from the signalling station. Considering the enormous distances across which it is claimed that these etheric signals may be transmitted, it is conceivable that he might receive such messages from all parts of the United Kingdom and even from the coasts of the North American Continent. Undoubtedly in such a case the mariner might complain that he was having too much of a good thing. Take, again, the project of supplying electric impulses sent from shore through a submarine cable lying on the sea bottom, with the object of inducing responsive impulses in a suitable receiver on board a ship within a certain area of influence. A trial was made by the Royal Commission on Electrical Communication between lightships and the shore of a plan of this kind at the Goodwin lightship, which was fitted with an elaborate arrangement of insulated wire coils in which it was hoped induced currents would be generated, but the Royal Commissioners report that it was found impossible to effect communication by means of the system, the electric energy being almost entirely lost in the sea. It is impossible to say what the genius of Mr. Marconi, and others who are working in the same direction, may ultimately accomplish; the application of the remarkable results obtained is at present quite in its infancy, but should the difficulties I have referred to be in time overcome, so that the system could be effectively applied for fog signal purposes, no one would welcome it more gladly than the authorities charged with the duty of indicating the dangers and safe courses in the waters adjacent to our shores.

What I have now said has reference only to the application of these methods for fog signal purposes. As a means of communication between outlying stationary lightships and the shore, there is every reason to hope that the system will before long be practically applied.

Instruments Tried at St. Catherine's.

We will now turn our attention to the sound-producing instruments subjected to test at St. Catherine's. For reasons which I need not here enter upon, the instrumental trials were a good deal devoted to comparisons of efficiency between the siren principle and the reed principle of producing sound, and between modified forms of each type.

The two methods of producing sound are doubtless more or less familiar to all present this evening, but a brief description of their application for fog signal instruments will not be out of place.

The Siren.

For all fog signal instruments giving blasts of sound a certain pressure of air or steam is essential, in practice ranging from 10 to 40 lbs. on the square inch. By force of this pressure the air or steam is urged through a pipe of comparatively small diameter into the trumpet, and thence out into the open air. But in the throat of the trumpet and in the direct course of the air or steam current is interposed the instrument which produces the sound. In the case of the siren the instrument now in use consists of a fixed cylinder with a certain number of longitudinal slits through which air or steam under pressure may pass to the interior. Inside this cylinder and fitting it very closely is another cylinder of similar pattern, with slits corresponding in number and shape to those in the outer cylinder, but capable of being rotated at a considerable speed. In this cylinder (5 inch, as used at the St. Catherine's station) there are 24 longitudinal slits or ports as they are usually termed, and it is clear that on the inner cylinder making one complete rotation, 24 coincidences of the ports take place. Assuming that 240 complete rotations occur in one minute, there will be 5,760 coincidences in that time, or 96 in each second. This would be a slow rate of rotation, but it is a convenient one for illustration. Around the outside of the outer cylinder the air under considerable pressure awaits an opportunity for escape, which is afforded at each coincidence, when a short, sudden and intense puff bursts through the coinciding ports into the interior space communicating with the trumpet, striking a sharp blow upon the air in the open trumpet. The rapid succession of these impulses creates sonorous waves, the length and musical pitch of which are, as is well known, determined by the speed of the rotation of the siren and the consequent number of vibrations produced in a second. When first used for sound-signal purposes the siren was not cylindrical, but consisted of two flat discs with equal number and size of slits, one fixed, the other rotating. The change to the cylinder form was thought desirable as being a more effective mechanical arrangement than the discs and as lending itself more readily to being self-driven by the air pressure. But experience has shown that the automatic rotation by the air pressure involves a possible loss of power and a more or less defective blast. In the automatic blast the speed of rotation of the siren commencing from a condition of rest involves an upward run through many degrees of speed to reach the required rate of rotation, the resultant sound beginning to be audible with a very low note, and running rapidly up to the required pitch. Thus the duration of the proper signal sound is shortened, and an effect produced which is not wanted. It is intended to remedy this defect by employing a separate motor to rotate the siren, whereby the rotation can be brought up to its proper speed before the air pressure is applied, and uniformity of pitch thus secured throughout the period of the blast.

Two sizes of cylinder siren were tried at St. Catherine's, viz., one of 5 inch diameter, as used in the Trinity House service, and one of 7 inch diameter, as used in the Scottish service, with some variations as regards the size and number of the ports regulating the volume of air passing through at each blast. Also, one new experimental form of disc siren, 7 inches in diameter, was also tried.

THE REED.

A few words now are necessary in reference to the opposition principle of producing blasts of sound, viz., the reed. In this case the sound is produced by the vibration of a more or less elastic metal tongue fixed in a box, into which the air under pressure enters periodically, and finds an outlet into the associated trumpet through an orifice which is covered by the metal tongue. The air pressure acting upon this reed causes it to vibrate, the effect being the orifice is alternately opened and closed; opened by the air pressure, and closed by the resilience of the metallic tongue. These alternations follow with great rapidity, and at each opening a small quantity of compressed air escapes, and the air in the trumpet receives a short, sharp shock, as in the case of the puffs through the siren. A careful adjustment of the reed is necessary, so that when the air pressure is applied the number of its vibrations shall correspond to the note pitch required. Too much air and too forcible a pressure may act detrimentally on the performance of the reed.

Four reed instruments were tried at St. Catherine's, viz.:—

1. The Stentor fog-horn (of Dutch origin), with one reed, sounded at the very high pressure of 120 lbs. on the square inch—265 vibrations per second.
2. The Barker reed horn, as used at Belfast, with three steel reeds, sounded at 40 lbs. pressure—about 353 vibrations per second.
3. The Taylor reed horn, with at first six, and afterwards two reeds, sounded at 40 lbs. pressure—about 353 vibrations per second.
4. The Trinity House service reed horn, with one steel reed, 3 5-16ths + $\frac{7}{8}$, sounded at 15 lbs. pressure—at first 496, afterwards 397 vibrations per second.

COMPARATIVE TRIALS.

The comparative trials made with these instruments may be classed as follows:—

1. Sirens *v.* sirens.
2. Sirens *v.* reed horns.
3. Reed horns *v.* reed horns.

SIRENS *v.* SIRENS.

The fog signal established at St. Catherine's for actual service consists of two 5-inch cylinder sirens with two trumpets. The seaward arc over which it is desired to spread the sound is about 220°, and the two trumpets are so fixed that their mouths cover that arc. The apparatus is arranged to give two blasts, one with a high note, one with a low note, every minute, each note being sounded by the two sirens working simultaneously, emitted from the two trumpets at the same time. Thus the combined sound of two sirens for each note is thrown over the arc required to be guarded. On the other hand, it was thought by some that the sound would be more effectually distributed by using a larger and more powerful siren, requiring more air and greater pressure for the blast, and pointing the trumpet as nearly as possible to the windward part of the arc. This question was put to practical test,—viz., St. Catherine's two-siren system *v.* the system of one large siren and trumpet pointed to windward. The observed results showed that when in or near the axia line of the single trumpet with the large siren its sounds were distinctly more powerful than those of the double siren arrangement, though the latter gave useful sounds at the same time. The wind on this occasion was not strong and the sea was smooth, and it is only fair to say that the line along which the observations were made, *i.e.*, the medial line between the two trumpets, apart from the slight opposing wind, was the least favourable for the St. Catherine's signal. Over the remainder and much greater part of the arc and in the rear of the large trumpet the position was reversed, the St. Catherine's sounds coming out with superior effect especially in the axes of their trumpets, while down to leeward the sounds of the single large siren fell away to feebleness, the St. Catherine's sounds being plainly heard all the while. From these comparisons it is concluded that the double-trumpet method is on the whole better for covering a wide arc with sound than the more powerful instrument directing its force through a single trumpet against the wind. This large seven-inch cylinder siren rotated by a separate motor and sounding very low notes was sent for trial by the Scottish Lighthouse Board, and it proved itself to be a very effective sound-producing instrument. Undoubtedly if two such sirens and trumpets of this kind had been fixed in a similar manner to those of St. Catherine's the result would have been most favourable to the Scottish instruments, but it would have involved a much greater expenditure of power, seeing that one such large Scottish instrument required a higher pressure, with a larger volume of air for blast than the two St. Catherine's sirens, and a consequent larger absorption of horse-power.

The trial of the new experimental form of 7-inch disc siren gave some interesting results.

It was fitted in a vertical trumpet with bent head, and, with a slow rate of rotation by means of a separate motor, was arranged to sound one very low-pitched note—the St. Catherine's signal being used as a standard of comparison —but as the disc trumpet was directed on the medial line, the two St. Catherine's trumpets were turned in, so that their axes enclosed an angle of 37°, instead of 120° as usual. The weather was fine and clear; wind easterly, light. At the commencement of the observations at a short distance from the station, the observers were astonished at the loudness of the sound from the disc siren, it filled all the air, and, to use an old expression, it made the welkin resound. At eight miles distant, the sounds of the disc siren were overwhelmingly predominant, while those of St. Catherine's were falling off; at ten miles, St. Catherine's sounds were lost, but those of the disc siren still retained their strength. The *Irene* proceeded at full speed on to a distance of 20 miles, the blasts from the disc siren being heard plainly, and as effective sounds throughout. At the distance of 20¼ miles it was necessary for the *Irene* to return; the sounds were still loud and distinct, and would doubtless have been audible at a much greater distance. In subsequent comparisons in similar quiet weather, the disc siren proved superior to the 7-inch cylinder siren with its low notes, but not to the same extent as in the trial with St. Catherine's. A different result, however, was experienced in different weather. On several occasions, with opposing wind and agitated sea surface, the low notes of the 7-inch disc siren proved inferior to the higher notes of the St. Catherine's and Scottish sirens, and in on instance with a wind of force 4 and the sea rough, *Irene* rolling, when a comparison was being made of the Scottish 7-inch cylinder with the 7-inch disc, no sounds were heard at two miles distance, and they were only picked up at 1¼ mile. I shall refer again to the question of the influence of wind, weather, and pitch of note on the transmission of sounds through the atmosphere. At present I am simply recording actual results of trials, and specially pointing out that an instrument which on one occasion transmitted its sound for over 20 miles, was on another occasion, under different conditions of weather, not audible beyond 1¼ mile.

SIRENS *v.* REED HORNS.

In the trials of sirens *v.* reed horns, it became evident at an early stage of the experiments, that the reed instruments were much inferior to the sirens in regard to power and effective sound range. To listeners out at sea, it seemed that in comparison with the siren sounds, those of the reed horns were lacking in volume and intensity. In weather of absolute stillness, some reed sounds were occasionally carried to fairly long distances. We all know that at times weak sound will travel far, but the least opposition or interference will silence it. Generally speaking, the reed sounds were found to be much more prejudicially affected by opposing influences than the siren sounds, and were extinguished at shorter ranges. A possible explanation may be that the shocks imparted to the air by the vibration of the reed are less intense and sharply defined than those created by the rapid cutting up of the air current under strong pressure, as is done in the case of the rotating siren, or perhaps some of the energy of the air pressure may be expended in overcoming the resistance of a stiff metallic reed, thus weakening the resultant blow on the air. But whatever may have been the cause of the comparative weakness and thinness of the reed sounds, there can be no doubt that the reed instruments tried at St. Catherine's, and supposed to be the most effective types of that form of sound producer in existence, were not able to compete with the sirens in use or about to be used as coast fog signals.

REED HORNS *v.* REED HORNS.

Comparing the reed horns with each other, the experiments showed that the Stentor instrument gave the best results. It proved to be simple in operation, uniform in sounding, gave a well sustained, full and clear note, and never once failed throughout the trials; but the very high pressure, 120 lbs. on the square inch, needed for its working, necessarily demands larger and more expensive machinery than that required for other reed instruments. The air or steam at the pressure stated is directed upon the reed from the inlet, but in working it does not absorb so much horse-power as other instruments. The next in order of efficiency as shown by the observations was the Trinity House service reed horn, of which pattern there are now in use six instruments at stations where a short range of sound is sufficient. During the progress of the trials some improvements were made in this instrument, the pitch of its note was lowered, the working pressure increased from 10 to 15 lbs. in the square inch, and other slight changes made. Thus improved, its performance was very satisfactory, having regard to the limited requirements it is intended to meet. Its economical working at a pressure of 15 lbs., and the very small volume of air used in each blast, its compactness and comparative cheapness of manufacture, are important recommendations of this instrument. The two other reed horns tested, viz., that of Captain Barker and that of Mr. Taylor, of Liverpool, did not prove so effective as the others mentioned. In the Barker instrument three reeds were employed in one trumpet, and in the Taylor horn at first six and afterwards two reeds were used. The throwing of three reeds into uniform vibration would doubtless absorb a good deal of the initial energy of the pressure and may have caused the resultant vibrations to be initially weak. The tuning of two or more reeds in one trumpet so that they shall vibrate in unison with each other is a troublesome business, and there must be considerable liability to interference of the sound waves. In the event of such interference the results as regards the emission of effective sounds would probably be very uncertain and unsatisfactory. If two or more reeds are thought to be more effective than one a better result might be obtained by supplying two or more trumpets, one for each reed, but possibly the inventors have considered this point.

Although the reed horn as now developed, must be regarded as inferior to the siren as a sound-producer, yet the Committee think it must be admitted that it has its advantages for situations where a sound signal of small range would be serviceable, or where there would not be space sufficient for the engines, pumps and reservoirs, necessary for compressing and storing air for sounding a siren.

TRUMPETS.

In connection with the sounding instruments employed the question of the associated trumpet or projector is an important one. It is assumed that in every case a trumpet of some sort is necessary. Trumpets of various shapes, sizes and material have been used, but of their real effect it is doubtful whether any very accurate knowledge has guided the makers. In France a very short trumpet is used on the ground that " beyond a certain length of trumpet there occur effects of resistance to the vibratory movement which tend notably to weaken the sound." In America long horizontal cast-iron trumpets have been much in use. In Scotland the horizontal form is favoured, and the Trinity House use vertical trumpets with bent heads. In every case the trumpet is conical of circular cross section.

ELLIPTICAL TRUMPETS.

Lord Rayleigh has drawn attention to the fact that from such a trumpet there is a liability to loss of sound effect to a listener at sea who is 20° or more out of the axial line of the trumpet, in consequence of possible difference of phase of the sound waves emitted at the mouth in a direction perpendicular to the axis, caused by the difference in distance of the nearest and furthest parts of the mouth. Lord Rayleigh also points out that with such a trumpet, as much sound is sent to the zenith as along the horizontal arc, which sound must be regarded as wasted. To remedy these two defects, Lord Rayleigh considers that the horizontal diameter of the mouth should not exceed half the length of the sound wave generated by the sounding instrument, and that the vertical diameter should be elongated to two wave lengths or more. The interference by difference of phase, or the waves being out of step, would be prevented by the horizontal diameter being half the wave length, for there would then be no reason for the waves getting "out of step," and the narrowness of the section at the top and bottom of the mouth would afford but little scope for the sound to be projected upward or immediately downward.

From the above considerations it will be seen, that as the horizontal diameter of such a form of trumpet must not exceed half a wave length of the sound sent through it, the trumpet must be made to suit the half wave length, consequently the pitch of the sound must be determined on before the trumpet is made. I trust I have paraphrased with some approach to correctness Lord Rayleigh's recent explanation of this matter at the Royal Institution, but if I have failed, I venture to hope that Lord Rayleigh will not mind making it more clear to you and to me. The working out of these ideas has been brought into practical shape by Lord Rayleigh's design of a new form of trumpet with a mouth of elliptical section. Two trumpets of this form were tried at St. Catherine's in conjunction with various sirens at different times, and although it is not always easy to dissociate the effect of the sound-producer itself from that of its associated trumpet, the observations so far as they went indicated quite clearly that a siren sounded in the large elliptical trumpet with its major axis vertical gave better results than a similar siren sounded in conical trumpets of circular section. Various considerations prevented this particular subject being pursued to a finish at the St. Catherine's trials, but the results obtained are regarded as so promising that the Trinity House have asked Lord Rayleigh with Mr. Matthews to follow up the subject with a view to the installation of one of these trumpets at a fog signal station for practical trial.

Fundamental Note of Trumpet.

In connection with the general use of trumpets, the desirability of causing the rate of vibration set up by the sound-producer inside it to be in unison with the proper note of the trumpet, was demonstrated at the trials. A tuning fork has a note of its own; when caused to vibrate it sounds one note only. An organ pipe will "speak" only to the vibrations of its own particular note, and there can be no doubt that each trumpet, as used for fog-signal instruments, has a fundamental note of its own. It is, therefore, considered as of great importance that the siren or reed should sound the same note as that appertaining to the trumpet. There can be no question that the best effects, as regards uniformity and loudness, are produced when the sound producer and the trumpet are in unison as regards the pitch of their notes.

Mushroom Head.

The new form of trumpet, known as the "Mushroom Head," was brought into service a few years ago, the object being to cause the sound produced by a siren or reed to be sent out over the near sea with equal strength all round the circle. This mode of distributing sound is most suitable for lightships where it is desired that the warning should be spread all round, and not sent in one direction only. In the trials it was proved that in and near the axial lines of the trumpets pointed in one direction, and also in the windward parts of the arc to be covered, the sounds from the mushroom trumpet were not so loud as those from the pointed trumpets, although, at the same time, they were quite sufficiently audible for signalling purposes; but out of the axes of the pointed trumpets, and in those parts of the arc in which the wind was not a strong opponent of the sound, the blasts from the mushroom head were heard more plainly than the others. The Committee considered, therefore, that the use of such trumpet heads on board light vessels is fully justified, and that they are very suitable for places where the arc to be covered is larger than could be effectually guarded by two trumpets, as at St. Catherine's.

Depression of Trumpet.

The question whether it was advantageous to depress a pointed trumpet with the object of causing the issuing sound to strike the near sea instead of the horizon, was considered during the progress of the trials, and the conclusion arrived at was, that with an instrument placed at a low elevation, very little, if any, advantage would be gained by depressing the trumpet, and that, in any case, sound projected downwards on to the sea might be subject to the action of interference, in consequence of the sound waves which would be reflected from the sea surface conflicting with the direct sound waves. For these reasons, the depression of the trumpet was not thought to be desirable.

Atmospheric Influences.

It will now be convenient to consider for a short time some interesting experiences of the Committee in connection with the propagation of sound signals through the atmosphere.

Wind.

Taking the question of wind. There can be no doubt that as fog of no great density will obscure the most powerful light, so an opposing wind of a certain strength will infallibly quench, at a very short distance, the most powerful sound that can be produced. I have cited an instance of the disc siren having on occasion been heard for 20¼ miles. This was in calm, clear weather, with a smooth sea. On another occasion, with a wind of force 3 to 4 blowing against the sound, the same instrument, operated under similar conditions as when it was carried to so great a distance, could not be heard beyond 1¼ mile. It seems almost incredible that so slight a force of opposing wind should have such an effect, but the fact remains. It must also be borne in mind that, with any wind, the sea surface becomes disturbed; and in addition to the actual effect of the wind in obstructing the passage of the sound waves, the continued noise of the splashing sea waves, and their dash against the sides of the ship, the noisy movements of the vessel herself, and additional local sounds on board caused by her unsteady movements, take possession of the ears, and tend to prevent sounds, already attenuated by coming from a distance from being clearly apprehended. It is of importance to take note of the fact that a sound heard on one occasion for 20 miles, may under different conditions be heard only 1¼ mile; and it shows clearly that it is of no use to quote the experience of one day as an indication of what may always be expected. People unacquainted with the capricious action of the weather on sound transmission are very apt to speak with undue confidence and make positive and misleading assertions regarding the performance of sound signals from one or two experiences of them.

FOG.

Fortunately when fog prevails the atmosphere is, as I have before observed, as a general rule undisturbed, and the sea surface quiescent. Moreover, at such time the air is usually in a more homogeneous condition both as regards temperature and density, and aqueous vapour is uniformly distributed throughout the area affected. Under these conditions the sound waves pass without meeting the obstruction which it may be assumed they encounter when the air is agitated or intersected with currents of varying temperature or vapour saturation. It so happened that no fog was experienced during the recent trials, but the results obtained in the experiments of 1874 as recorded by Professor Tyndall, entirely supported the views above expressed. With this knowledge in our possession it may fairly be argued that the favourable results obtained in the trials at St. Catherine's, in clear weather, would have been fully borne out and possibly surpassed in foggy weather. I do not of course assert that fog is never accompanied by wind or a noisy sea, but such a condition of things is very exceptional, and wind generally has the effect of dispersing fog.

SILENT AREA.

In the course of the observations made on the sound signals at St. Catherine's, some very marked effects of what has been termed a soundless zone or silent area, were experienced. The observing party on board the *Irene* would commence observations on an arranged series of sounds, at about a mile from St. Catherine's point, intending to steam out on a certain line of bearing, to test their relative effectiveness at various distances. On starting at the mile distance, the sounds would all be very loud, but as the vessel proceeded out they would fall away in strength, becoming fainter and fainter until at a distance between two and three miles they would be barely audible or quite lost. Shortly after the three miles' distance, the sounds would be recovered, swelling out into full hearing, and would be carried in loud and distinct signal to a considerable distance. This was not a single experience, but one which occurred on several occasions. Many years ago the phenomenon attracted the attention of General Duane of the United States lighthouse service, and since then its effects have more than once puzzled members of Trinity House Committees, when testing the efficiency of established fog signals. In the St. Catherine's trials, the effect was especially noticed when the weather was fine and calm with a smooth sea; with a marked disturbance of the air or the surface it was not noticeable. The question is, what becomes of the sound motion during the period in which it is practically lost to an observer on a vessel's deck. Professor Tyndall has held that it is caused by the sound waves reflected obliquely from the sea surface interfering with the passage of the direct waves above the sea surface. But this apparently only affords a partial explanation of the occurrence, for as Lord Rayleigh has pointed out, on this theory the interference should take place always, whereas it only occurs very exceptionally, and the *Irene* made very many journeys along the medial line and only experienced the silent area on five occasions. What becomes of the lost sound? All sorts of theories have been mooted as possible explanations, but none have yet completely solved the question. To do so would probably need prolonged and continuous observation, not only on the line in which the effect was experienced but over other parts of the arc at corresponding distances and out of the axes of the sounding instruments; also careful observations at the sea surface, and possibly by means of a captive balloon at varying distances above would be necessary, so that the whole area might be examined with the object of discovering where the temporarily lost sound had gone. Time did not permit the Committee to pursue the investigation of this phenomenon, but having observed its effect they are strongly of opinion that all sea-faring men should be made aware of such possible interference with the efficiency of a sound signal at a distance where it ought to be serviceable, and that when the master of a vessel does not hear a fog signal when he thinks he ought to hear it, he should at once have recourse to the lead in order to verify his position.

SEA ECHOES.

Some very striking effects of echoes from the sea were observed at St. Catherine's. Standing on the cliff at a short distance from the signal station it was observed that in fine clear weather the blasts of the sirens or reed horns were almost immediately supplemented by echoed sounds, re-inforcing the direct sound while it lasted, and continuing to sound for some time after the direct blast had ceased. These echoes seemed to start from a point corresponding to the prolongation of the axis of the trumpet from which the sounds were emitted, and with great rapidity to spread out over the sea expanse as though a scattered army of trumpeters in quick succession sounded their blasts from all parts of the horizon. Carefully timed the echoes were observed frequently to last for thirty seconds. This striking effect would be observable when the sky was cloudless, the sea smooth and placid, and with no vessels in sight. Clearly the echoes were aerial, possibly caused by reflections of the sound waves between areas of varying density, otherwise acoustic clouds. Professor Tyndall has suggested that the "duration of the echo is a measure of the atmospheric depths from which it comes." If this were so length and strength of the echoes might afford a rough indication of the relative penetrating power of the instrumenis without making observations from sea. During the experiments at St. Catherine's the operators constantly noticed these echoes from seaward which proved to be weak or strong, short or long, according to the weakness or strength of the sounds as heard by the observers on the *Irene*. When the atmosphere was disturbed by wind, and the sea surface was much agitated, the echoes were very short or non-existent. It has been suggested that possibly under some circumstances these prolonged echoes might prove misleading. Suppose the master of a vessel within range of the signal were to mistake the echoed sound for the true signal it might possibly bewilder him, to say the least of it, for the echoed sound would probably reach him from a direction opposite to that from which the true sound was sent out. The possibility of such a mistake occurring is no doubt remote, but it is conceivable that the knowledge that such a thing is possible might afford a perplexed mariner some assistance in a position of doubt and difficulty. Frequently observers on board the *Irene* heard the echoes to seaward at two or three miles distance from the signal station.

THE PITCH OF NOTES.

The question of the relative value of high or lowpitched notes as regards penetrating power, has received a good deal of attention in these experiments. Formerly the signal blasts were made on one note only, G or A in the treble clef, these notes being taken as being about the middle of the scale of audible musical sounds,—easily made and easily apprehended. The necessary distinctions were then obtained by varying the number and lengths of the blasts and intervals. When it was decided to introduce two notes, high-low, into one signal, the question of the relative pitch of the two sounds had to be considered. The difference of two or three notes between the sounds, was regarded as sufficient, and since then the combinations possible up to a four-sound signal have been practically applied on our coasts, the principle being that the high and low notes must be brought into direct contrast. After the adoption of this system, it was occasionally reported that although both notes of a signal had been sounding at a certain time, one only was audible, or one was much more powerful than the other. In consequence notes of different pitch were tested at St. Catherine's, and as a result of many observations, it was deemed advisable to lower the pitch of the sirens which were under trial. When the 7-inch disc siren was being experimentally tried in the large trumpet, special efforts were made to adapt the speed of rotation of the siren, and the consequent number of sonorous vibrations per second to the inherent note of the trumpet. Starting at between 300 and 400 vibrations per second, the speed of rotation was gradually decreased without any satisfactory result, the emitted sounds being gruff and imperfect, until the very low rate of 98 vibrations per second was reached, and then there issued from the trumpet a deep, full note, apparently of great power. When observations came to be made on the sound so produced, the observers with one accord adjudged it to be the most powerful sound that they had heard, and it was on this occasion that the sound was carried for over 20 miles, while the very efficient St. Catherine's station signal was lost at 10 miles. This result was corroborated again and again in subsequent comparisons, but it so happened that the weather was on every occasion fine and undisturbed. When, however, a change of weather came, with noisy wind and sea, the result was entirely different. This great sound was inaudible at a distance beyond 1¼ mile, while the high-pitched notes of St. Catherine's asserted themselves as superior. This, again, was borne out out by further comparison made in similar disturbed weather, and these experiments have led the Committee to conclude that "for calm weather a low-pitched note is more suitable than a high-pitched one; but when the wind is opposed to the course of the sound-waves, and the sea is rough and noisy, a high-pitched note penetrates further than a low-pitched one."

It would, I venture to submit, be a good thing if railway engineers would take note of the fact that a low-pitched sound would be quite as effective for all signalling purposes as those horrible ear-piercing shrieks their engine drivers enjoy so much. A low-pitched sound is much less trying to listen to than a high-pitched one, and if it serves the purpose as well, if not better, there ought to be no reason why railway companies should not consider the comfort of their passengers and the public generally and introduce low-sounding notes for their whistles.

GENERAL RESULTS.

It will be obvious that the recent experiments have yielded some really valuable results. They have demonstrated more clearly than ever, that the propagation of sound through the atmosphere is exceedingly capricious; that there are hindrances to sound travelling which may have been the cause of disasters, and which might afford an explanation of the extraordinary failures to hear fog signals which have been from time to time complained of, it being subsequently ascertained that the signal was in full work all the time. They have yielded a great deal of most useful information in regard to the details of the instruments best adapted for fog signal purposes and the mode of working them, and they have furnished material on which further improvements and developments may proceed. There are still many things which are at present inexplicable, as regards sound transmission, but "knowledge comes and wisdom lingers," and in regard to the value and practical use of sound signals for coast guarding purposes, we now know much more than ever was known before.

Undoubtedly sound is an imperfect medium for carrying signals to the mariner during fog, but who can show anything which is better? If it could be superseded by any system more effective and trustworthy, the seafaring community and those entrusted with the duty of marking coasts would have much cause for rejoicing; and it is not too much to hope that before many years have passed some electrical development may be brought into successful use for this purpose. But there is no immediate prospect of such a change, and meanwhile it remains to make the best use possible of sound, the only means available. The Trinity House and other Lighthouse Authorities with the invaluable aid of Lord Rayleigh and the engineers of the three Lighthouse Boards, are most anxious to do all that is possible to assist the mariner, and, by such trials as I have referred to, are endeavouring to introduce improvements and overcome the many difficulties that surround the question, with the object of so developing sound signals that, until displaced by some better system, they may be made more and more effective for conveying warnings to mariners when fog hides all things from sight.

DISCUSSION.

The CHAIRMAN thought Mr. Price-Edwards had explained in a very lucid way the many difficult questions which arose in connection with this work. Mr. Price-Edwards had referred to the system of signalling by electric waves and of the advantages which such a system would undoubtedly possess in being entirely independent of atmospheric conditions. On the other hand, he had pointed out that it was of no use merely to be told by a signal that such and such a station existed. The mariner required to know either the direction in which the station lay or the distance he was away from it. At present, experience was deficient on such matters, but he could not help thinking that this need no longer remain the case. British ships of war were fitted with the Marconi system of signalling apparatus, and he presumed experience must be gradually accumulating with regard to the distance the signals would penetrate. If one knew that when a signal was being received, it was sent from a distance, say, of less than 10 miles, it would be most valuable information for fog-signal purposes. Whether in the future it might be possible to give an indication of direction was at present an open question, although it had been claimed that such information was possible. Many to whom the subject was new must have been struck with the enormous development of modern sirens. He had been astonished when he learned the great horse-power employed in the production of sound. The totals used in the ordinary Trinity House service were big enough, but in recent experiments with a siren, designed and erected by the Scotch Board, which gave two notes, as much as 600 horse-power were required to produce the higher one. Whether this enormous horse-power was really put into the sound was a complex question. If 600 horse-power went into the sound it was difficult to believe that it would not be capable of penetrating even greater distances than could now be reached. When powerful sounds were heard on certain occasions at great distances, whereas on other occasions they were only heard at comparatively short distances, such as 1½ mile, one could not help thinking that the problem was only half solved. He was sure Mr. Price-Edwards was in no part of his paper more right than when he insisted on the importance of not assuming that because a signal could be heard on one occasion that therefore it could be heard on another. The nomenclature of the instruments was a little confusing. Mr. Price-Edwards always called the conical prolongation of the instrument the trumpet, while sometimes it was called the horn. In the reed instrument the word reed was specially applied to the vibrating tongue. If the etymology of the word were considered, it would be found that the reed was really the tube. Strictly speaking, what vibrated at the end of the tube, which was the approximate source of sound, was the tongue. He believed that usage was on the side of Mr. Price-Edwards, and he only raised the question as instancing the difficulty of choosing the correct word. One phenomenon which had struck him as a novice, in connection with the experiments at St. Catherine's, was the echoes to which Mr. Price-Edwards had referred. It was perfectly astonishing on some occasions to note the force with which the echoes returned, apparently from nothing in particular. The echoes were first appreciated at the moment the sound from the siren stopped. If the observer closed his ears during the few seconds the siren was actually sounding, and then suddenly opened them, he would be astonished with the vigour of the sound, and could hardly believe that the instrument was not still in operation. The long duration of the echoes was also a very remarkable fact, and he thought must be taken to prove what Professor Tyndall had stated, that the sounds really came from depths of the atmosphere, extending in many cases to two or three miles away from the instrument itself. Again, the characteristic of all sound signals remained, that what the observer heard on one day, he did not equally hear on another.

Captain GEORGE R. VYVYAN (Deputy-Master, Trinity House) after thanking the reader for his paper, said Mr. Price-Edwards was too modest to state that the mushroom horn, which had been accepted as the best form of all-round fog sirens, was suggested by himself. Mr. Price-Edwards had not touched upon the extremely capricious, fleeting, and patchy nature of fogs. Coming up in the train, only that afternoon, from the West of England, he passed through the border of a fog. The effect was most extraordinary. Sometimes the train took half a minute, sometimes a minute, and sometime two minutes in running through banks of fog, but always the plunge from clear sky to dense fog was instantaneous. That indicated the extreme difficulty lighthouse keepers had in deciding when to start a fog signal. It often happened that a lightohuse was in clear weather, whereas a little way out at sea fog existed, and because the horn was not blown negligence was attributed to the lighthouse keeper. There was also the curiously interesting fact that some places were more liable to fog than others. The north side of the Bristol Channel was one of the foggiest places in the Kingdom, while the north coast of Devon was the freest, yet the distance separating those two points was only 20 miles. It would be a benefit to sailors if they knew that fact. In conclusion, he emphasised the necessity of sailors using the lead whenever they could not hear a siren which they thought they ought to hear.

Sir WILLIAM WHARTON, K.C.B., F.R.S., expressed his disappointment that after the exceedingly exhaustive experiments which had been made no conclusion had been arrived at with regard to the wonderful areas of silence. He endorsed Captain Vyvyan's remarks as to the necessity for not implicitly trusting sound signals. The Admiralty for many years, in its publications had insisted on the necessity of seamen constantly using the lead and remembering that fog signals might not be heard. The facts related with regard to the penetrability of a low note were extremely interesting, and he hoped the Trinity House officials would ascertain whether such a note might not be used under more general conditions.

Mr. F. W. FLETCHER inquired what experiments had been made in trumpets tuned to particular tones. Could not a trumpet be revolved for a certain area, in a similar manner to a light in a lighthouse? Would not the sound be dispersed, by those means, over a larger area?

Capt. GEORGE C. BURNE said, that during 22 years of experience at sea, he had on three or four occasions entered a wall of fog off Cape St. Vincent and other parts of the coast in which, standing on the bridge, he had not been able to see the jibboom, although the after part of the ship was perfectly clear.

Captain WILSON BARKER thought the question of sound was a meteorological problem and depended on the difference of temperatures in different areas. He did not think it would ever be possible to get any sound, such as they had at present, to penetrate the areas, although it would be possible if a sort of

sound could be produced. In any case, it
l not do away with the absolute necessity of the
having frequent recourse to the lead. It was
to be expected that the low notes would pene-
better than the high ones; the larger waves
carried through where the smaller and higher
would not penetrate.

ptain G. C. Frederick, R.N., said, that having
ded some of the experiments off St. Catherine's, he
een struck with the fact that the silent area was
st always invariably met with at a distance of
een 1½ and 3 miles from the instrument. The
er of the paper had stated that it might be due to
ound waves reflected from the water meeting the
t waves, the ordinary notes thus being interfered
. If the height of the instrument above the water
ed the silent area to be at that particular distance,
ight be found that at other places where the
als were at a greater height the sound area was at a
er distance from the land. Mr. Price-Edwards had
red to the disagreeable sounds produced by the
high notes and the piercing sound made by the
tles of railway engines, of which so many people
plained. That penetrating and disagreeable sound
often required to draw people's attention to the
that something was in the way—a soft sounding
was not sufficiently startling. Although a deep
might go farther, it did not attract attention so
kly as a high note.

aptain Anthony S. Thomson thought the
ler of the paper had scarcely given due weight
the possibilities of wireless telegraphy for the
ect under discussion. From the very first it
been possible to give some direction to the wire-
messages. Mr. Marconi in his first experiments
ceeded with reflectors in confining the perception
his signals to a certain limited arc. That fact
g sufficient for commercial purposes he abandaned
nd directed his attention to distance signalling.
ving seen the experiments made he knew that
er inventors had been enabled to give indication of
ction up to distances of about 600 yards. By
ploying two vertical wires instead of one it was
nd that when the vertical wires were in one with
observer, a maximum throw was obtained on the
anometer, and when the two vertical wires were at
t angles to the direction of the observer there was
inimum effect. That could be applied to a ship
the following way:—If a ship had two vertical
es, one on each mast, on receiving a signal she
would merely have to alter her course, so as to
ive either a maximum or minimum effect; she
ld then know whether the sound was in line or at
t angles with her two masts. With regard to
ance, the Chairman had stated that experience
ld enable them to know practically how far off
ignal was. If wireless fog-signals were established on the coast they would probably work night and day in fine weather, and as uniformly as possible. Any ship possessing a wireless installation would notice particularly in clear weather how far they could perceive the signals, and no doubt in time they would be found very useful both for direction and distance. It was only necessary for a ship to know the direction and distance of a fog signal approximately; about four points was quite sufficient for direction, and it was quite sufficient if the ship knew she was within reasonable limits as to distance. Mr. Price-Edwards' statement in regard to the inefficiency of the ordinary sound fog signal made it important that the development of fog signalling by wireless telegraphy should be developed.

Captain A. W. Clarke, after alluding to the absolute necessity of sailors in foggy weather using the lead, emphasised the importance of the ship being stopped for the purpose of listening for the fog signal. During the experiments it was constantly found imperative, even on a little ship like the *Irene*, which made only a small noise, to stop to hear the signal at certain distances. This was all the more necessary in large mail boats and cruisers, which, even at half-speed, made a great noise.

Mr. N. G. Gedye pointed out that, although 600 horse-power were required to produce a continuous blast in the Scotch siren, as the siren only sounded for two seconds in a minute 1-30th of 600 horse-power. was sufficient to drive the siren in practical work. The experiments had proved satisfactorily that *pro rata* of horse-power the siren was the most efficient signal. Some time ago he saw some experiments carried out by Mr. Marconi for gauging the direction of the signal. If the coherer were fixed south, by means of the reflectors it was possible to receive a signal within an angle of 15° on either side of the centre line. The experiments were so arranged that with the coherer within 30° of the receiver a small bell was rung; directly the receiver passed out of the angle of 30° the bell ceased. The method adopted in the experiments at St. Catherine's for gauging the relative efficiency of the various signals was open to criticism; it was hardly as satisfactory as finding the ultimate limit of the various sounds. From experiments made by the French lighthouse service at half-a-dozen first-class siren stations, he believed that fifty or sixty of the blasts given by the sirens, during the year, could be heard at a distance of six nautical miles. The Stentor horn consumed considerably more power than other types of reed horns. The little service horn of Trinity House consumed only 2 cubic feet of air per second of blast, and 15 lbs. horse-power, against very much larger figures of the Stentor. The small hand-power horn consumed ·65 cubic feet of air per second of blast, as against 6 or 12 by the Stentor. He was sorry tests with explosive signals had not been made.

The Rev. COURTENAY GALE asked if Mr. Price-Edwards could give any information on Hook Jones's system of fog signals. He did not think the reed system had been given a fair trial, because although in the sound shown by Mr. Price-Edwards there were 24 reeds, only three had been employed. It would be interesting to know if harmonic sounds had been used.

Lieut.-Colonel ALLAN CUNNINGHAM said the instruments used had the power of emitting sounds varying in duration, frequency, pitch, and intensity. Had any success attended the attempt to make the lighthouse spell out its own name, by means of the various combinations of these qualities? He also asked whether it was not possible to apply the system of sound signals, not only for the protection of travellers on the sea, but those on land.

Mr. PRICE-EDWARDS, in reply, said the question of harmonics had not been entered into, because a sound signal was not intended to produce musical sounds, but the most effective sound which could be heard at sea. The scale had been gone through, and the effects of various pitches tried, and it had practically been proved that a note with 98 vibrations per second was, on the whole, more effective than anything else. In connection with the question of the low note as against the high note, the experiments led the Committee to the conclusion that when the weather was quiet, and the conditions generally equable, the low note had a much greater penetrating power, and was more effective than the high note; but when the air was agitated, and the sea noisy, the low note sounds were not heard so well ass of a very high pitched note. It was quite true that Mr. Marconi had claimed for his system of reflectors that within a certain quadrant, or a wider angle, he could make it clear where a sound came from, but, as far as he had read the statements, they were of a more or less vague character. In any case it seemed that it must be an angle, and a seaman might make a great mistake in that angle. In regard to the horse-power taken by the Scotch siren, it was quite true that if it was cut up and the proportion taken by each blast was calculated, it must necessarily be less; but in the computation made with all the instruments the horse-power was taken for producing a continuous blast. There was a good deal to be said with regard to the method of calculating the result. Different persons held different opinions as to how best the value of the sounds should be recorded. The method adopted was quite uniform, and was followed throughout the observations, and in the end when the figures recorded by the various observers were tabulated and worked out they showed a remarkable agreement with the general opinions formed by all the observers personally. Explosives had not been tried because it was assumed at the commencement of the experiments that the explosive signal had a character of its own, and stood by itself. The results of trying explosives against sirens were well known, and it was therefore considered not only unnecessary but waste of time to do so on the present occasion. He doubted whether any fog signal could be made to spell out its own name, because it would have to do so by sounds of different kinds, which would necessarily only add to the difficulties of the problem.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Price-Edwards for his paper.

Miscellaneous.

THE ARTIFICIAL FLOWER INDUSTRY IN SAXONY.

Artificial flowers, leaves, and plants form a very important article of export from the district of Dresden. Several large factories in Dresden produce a considerable quantity, but the principal place of manufacture is at Sebnitz, a town of 8,500 inhabitants, 35 miles north-east from Dresden, close to the Bohemian boundary. The origin of the artificial flower industry, according to the most reliable statistics, dates back to about 1840, and was due to the immigration of a few makers of flowers from Bohemia. At first only a very inferior grade was made, chiefly of tissue and thin coloured paper. In time the industry made progress, and business connections were effected with foreign countries. Sebnitz is now not only the centre of the artificial flower trade in Germany, but favourably competes with its French rivals. While it is admitted that the Paris finish, and especially the exquisite French taste, cannot be excelled, yet Sebnitz, according to Consul-General Cole, of Dresden, places every year a very handsome selection of high-class novelties before the buyer. Up to the year 1870 very little export bnsiness was done from Sebnitz, but the Franco-German war, disastrous to most branches of trade, was directly beneficial to the flower industry. During the siege Paris could not supply all requirements, and Sebnitz was called upon to supply the demand. This gave a remarkable impetus to its trade. At the present time there are some 430 manufactories of artificial flowers, leaves, plants, fruits, &c., in the district of Dresden, of which 330 are located in Sebnitz and the neighbouring villages, and 100 in Dresden and its suburbs. Of these concerns, about one-third are engaged in the wholesale business, and the largest manufacturers employ from 250 to 1,000 persons. The total number of persons engaged in the trade is estimated at 10,000, the larger proportion being females. Practically no machinery is used in the manufacture of artificial flowers, hand presses being used to cut out, emboss, and give shape to the leaf or blossom. All work such as dyeing, colouring, stemming, shaping, shading, mounting, waxing, binding, &c., is done by hand. Work is paid for by the piece, dozen, or gross—and the earnings vary from 30s. to 50s. per month for females, and from 35s. to 80s. for males, according to age, kind of work, skill, and diligence. Children under fourteen years of age are prohibited by law from engaging at work in factories, and must have passed the term at a public school before they can obtain such permission. The most important feature of the artificial flower trade, is the house industry, and it may safely be stated that two-thirds of the work is done outside the factories by families who are supplied with the cut material, ready for stemming, shaping, binding, &c. A factory employing 100 persons in its establishment gives work to 300 or 400 outside. There is hardly a house in Sebnitz and neighbourhood, where artificial flowers are not made, and even the farmer who works in the fields in summer time, makes flowers during the winter. The tools used for cutting out the different shapes of leaves, parts of blossoms, &c., are made in Sebnitz and Dresden, and the largest manufacturer has over 500 different tools, some of which, especially those for cutting out fine fern leaves, costs as much as £5 each.

EVOLUTION OF THE WRITING MACHINE.

The following particulars respecting early typewriting machines, are taken from a lecture lately delivered by Mr. A. E. Morton, at the St. Bride's Institute:—

"In 1714, Henry Mill, engineer-in-chief to the New River Water Company, devised a writing machine, and obtained letters patent for it. He seems, however, never to have developed his invention: and, strange as it may seem, no effort with but one exception, in France in 1784, appears to have been made for 127 years to produce a writing machine. The first American attempt was made by William A. Burt, in 1829. Sixteen years later, a patent for a writing machine was granted to Charles Thurber. Between 1850 and 1857 several attempts were made in Europe and America. The problem engaged the attention of Sir Charles Wheatstone, the inventor of the dial telegraph. Wheatstone invented three writing machines, all of them marvels of ingenuity, and all more or less capable of turning out good work. In 1857, Peter Hood, a blacksmith, afterwards a watchmaker, of Kirriemuir, invented a machine, made for Mr. James Arrol, a blind gentleman of Glasgow. Pratt, of London, patented a machine in 1866, and exhibited it before the Society of Arts in the following year. It was not a commercial success, although it printed neatly and more rapidly than handwriting. It was too intricate and delicate a piece of mechanism, and would hardly stand practical use. But Pratt was the first really to complete a typewriter, and his machine was a great stride in advance of everything previously accomplished. Pratt affirmed that the ideal at which he aimed was an instrument possessing sufficient rapidity for verbatim reporting. An article commendatory of Pratt's invention appeared in the *Scientific American.* This article appealed to the inventive ingenuity of C. Latham Sholes, Collector of Customs, who read it. By the spring of 1868 Sholes had finished his first crude machine; letters were typed with it and sent to acquaintances and friends. The story of his subsequent labours in developing the machine is well known. Since 1875 much has occurred in the typewriting world. Forty-one machines have appeared on the English market.

Obituary.

Sir Villiers Lister, K.C.M.G.—On Wednesday, February 26th, Sir Villiers Lister, who had been a member of the Society of Arts since 1863, died of acute bronchitis, at his town house, 64, Cadogan square. Thomas Villiers Lister was born in 1832, the son of Thomas Henry Lister, of Armitage Park, Staffordshire, Registrar-General, and his wife, Lady Maria Theresa Villiers, sister of the 4th Earl of Clarendon. Mr. T. H. Lister was the author of the once famous "Granby," and other novels, and of a Life of the great Lord Clarendon. Lady Theresa Lister (afterwards the wife of Sir Cornewall Lewis), was the author of a work on the famous Clarendon Gallery of Portraits, under the title of "Friends and Contemporaries of Lord Chancellor Clarendon." Sir Villiers Lister was educated at Harrow and Trinity College, Cambridge, and entered the Foreign Office in 1853. He was several times private secretary to the Earl of Clarendon, when he was Secretary of State for Foreign Affairs. He was attached to Lord John Russell's special mission to Vienna, 1855; to the Earl of Clarendon's special mission to Paris, 1856; to Earl Granville's special embassy to Russia, 1856; and to Lord Clarendon's special embassy to Prussia, 1861, on the occasion of the Coronation of the King, William I. He held the office of Assistant Under Secretary of State for Foreign Affairs, 1873-94. Sir Villiers Lister was an active member of the Council of the Society of Arts for many years, 1883-86; Vice-President, 1888-90, 1892 95, and 1897-1900.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

March 12.—"The Utility of Alkaline Phosphatic Manures." By John Hughes, F.I.C.

March 19.—"Electric Traction. London's Tubes, Trams and Trains." By J. Clifton Robinson, Assoc.Inst.C.E., M.I.E.E.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 13.—"The Indian Famine of 1899, and the Measures Taken to Meet it." By THOMAS WILLIAM HOLDERNESS, C.S.I. SIR ANTONY PATRICK MACDONNELL, G.C.S.I., will preside.

APRIL 17.—"Recent Developments in Punjab Irrigation." By SIDNEY PRESTON, A.M.Inst.C.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab.

MAY 1.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G.

APRIL 22.—"British Commercial Prospects in the Far East." By BYRON BRENAN, C.M.G., late H.M. Consul-General at Shanghai.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock :—

APRIL 8. 8 p.m.—"Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington. H. H. STATHAM, F.R.I.B.A. will preside.

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

J. D. GEDDES, "Application of Photography to Printing." Three Lectures.
March 3, 10, 17.

LECTURE II.—MARCH 10.—The photogravure process—Variations—Resin and bitumen grains—Mechanical grains—Principles and working of the Collotype—Woodbury type and Stannotype processes

LECTURE III.—MARCH 17.—Trichromate photography—General principles—The preparation of blocks for printing in colours—Direct and indirect processes—Printing inks and printing machines—Application of the three-colour process to artistic and commercial illustration.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures.
April 14, 21, 28, May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. D. Geddes, "Photography as Applied to Illustration and Printing." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. H. Bedells, "Notes on the Insurance of Buildings against Fire."

Geologists, University College, W.C., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, MARCH 11...Aeronautical (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 8 p.m. 1. Major W. L. Moëdebeck, "The Development of Aërial Navigation in Germany." 2. Miss Gertrude Bacon, "Balloon Photography." 3. Dr. F. A. Barton, "Some Further Notes on the Barton Air Ship" (with exhibition of Model).

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. B. Poulton, "Recent Researches on Protective Resemblance, Warning Colours, and Mimicry in Insects." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, S.W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W.. Adjourned Discussion on Messrs. W. M. Mordey and Bernard M. Jenkin's paper, "Electrical Traction on Railways."

Photographic, 66, Russell-square, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Lord Lamington, "Some Notes on Queensland."

Asiatic, 22, Albemarle-street, W. 3 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

WEDNESDAY, MARCH 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Mr. John Hughes, "The Utility of Alkaline Phosphatic Manures."

Geological, Burlington-house, W., 8 p.m.

Royal Literary Fund, 7, Adelphi-ter., W.C., 3 p.m. Annual Meeting.

United Service Institution, Whitehall, S.W., 3 p.m. Lieut.-Col. A. G. Haywood, "Volunteer Artillery: Past, Present, and Future."

THURSDAY, MARCH 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Thomas William Holderness, "The Indian Famine of 1899, and the Measures Taken to Meet it."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 6½ Suffolk-street, Pall-mall, S.W., 8 p.m. Mr. E. O. Sachs, "Artistic Electric Illumination."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. T. Reed, "Caricature In and Out of Parliament." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on papers :—1. Major-General C. E. Webber, "Electric Shock and Legislation Thereon." 2. Mr. F. B. Aspinall, "Electric Shocks." 3. Mr. A. P. Trotter, "Electric Shocks at 500 Volts."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

FRIDAY, MARCH 14...Royal Institution, Albemarle-street W., 8 p.m. Weekly Meetings, 9 p.m. Prof. Silvanus P. Thompson, "Magnetism in Transitu."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. H. J. Deane, "The Use of Long Steel Wires in Surveying."

Astronomical, Burlington-house, 5 p.m.

Junior Engineers, Westminster Palace Hotel, S.W., 8 p.m. Mr. Percival Marshall, "The Uses of Engineering Models."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MARCH 15...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Some Electrical Developments." (Lecture V.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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NEXT WEEK.

Monday, March 17, 8 p.m. (Cantor Lecture.) J. D. Geddes, "Photography Applied to Illustration and Printing." (Lecture III.)

Wednesday, March 19, 8 p.m. (Ordinary Meeting.) J. Clifton Robinson, Assoc. Inst.C.E., M.I.E.E., "Electric Traction. London's Tubes, Trams, and Trains."

Further details of the Society's meetings will be found at the end of this number.

LEGACY TO THE SOCIETY.

The Council desire gratefully to acknowledge the receipt of a legacy of £50 left to the Society under the will of the late Mr. W. Anthony Herring. Mr. Herring, who died in January, 1901, was elected a member of the Society in 1870.

CANTOR LECTURES.

Mr. J. D. Geddes delivered, on Monday evening, 10th inst., the second lecture of his course on "Photography Applied to Illustration and Printing."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, March 13th, 1902; Sir Antony Patrick MacDonnell, G.C.S.I., in the chair.

The paper read was "The Indian Famine of 1899, and the means taken to meet it," by Thomas William Holderness, C.S.I.

The paper and report of the discussion will be printed in a future number of the *Journal.*

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1902 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 5th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For.Memb.R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For.Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For.Memb.R.S., Member of the Institute of France.

In 1878, to Sir Wm. . Armstrong (afterwards Lord Armstrong), C.B., .L., F.R.S, In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S:I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (now Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Prof. David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

In 1899, to Sir William Crookes, F.R.S.

In 1900, to Henry Wilde, F.R.S.

In 1901, to HIS MAJESTY THE KING.

A full list of the services for which the medals was awarded was given in the last number of the *Journal.*

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

In order to afford accommodation to the students of Institutions who may wish to send in a few candidates for the above examinations, but may not have a sufficient number to justify their holding an examination of their own, the Technical Education Board of the London County Council has arranged for the organization of a London centre for the *viva voce* examinations only. The Secretary of the Board, Dr. William Garnett, is now prepared to receive applications for these examinations from the Secretaries of Public or Endowed Schools, Polytechnics, Technical Institutes, or similar institutions.

As soon as it is known that a sufficient number of candidates are likely to present themselves in each subject, a convenient date will be selected, and the necessary arrangements made for holding an examination in French, in German, and in Spanish.

Any Institutions which can send in a sufficient number of candidates, and would therefore naturally prefer to have the examination conducted on their own premises will not be affected by this arrangement.

Information as to the nature of the examinations can be obtained on application to the Secretary of the Society of Arts, Adelphi, W.C.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal,* cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 27, 1902; The EARL OF HARDWICKE in the chair.

The paper read was—

THE INDUSTRIAL DEVELOPMENT OF INDIA.

By NILKANTH B. WAGLE, B.A.

In May of 1900 a master-hand laid the subject before a similar meeting of this Society in a most able manner. The different official positions Mr. Baines had occupied, and his natural eagerness to mix with the people, afforded him invaluable opportunities for obtaining a correct knowledge of the present industrial condition of India, judged both by the views and aspirations of the people, and the overwhelming responsibility of the Government, to whose archives he had free and familiar access. Mr. Baines chiefly aimed at describing the industrial progress made by India during the few years antecedent to his paper, as well as the present industrial condition of the country. The paper, in that respect, was complete in itself. But it is to be remarked that he did not indicate any scheme for future work in developing the industries of India.

This is to be regretted for two reasons :—1st, Mr. Baines was highly qualified to point out to us fresh channels for the nation's work ; and, 2nd, his lead would have been most valuable at the present time. Attention was drawn to this subject in the early sixties, and even long before. A paper on commerce in India, by Mr. Dadabhai Naoroji, was read before this learned Society in 1871, and in 1877, a debate on the conditions and methods of industrial progress in India was opened in a practical manner by Mr. Martin Wood, at a meeting of the Bombay Branch of the East Indian Association, under the presidency of the late Sir Manguldus Nathoobhoy, whose princely benefaction to the Bombay University enables that body to support seven students in Europe, for industrial or technical education ; and the able discussion which followed that paper shows how keenly the want of industrial development was felt in those days. It was in 1885 that Mr. Naoroji wrote an elaborate and well thought out scheme on the subject. The continuous and eminent services to this cause of Dr. (now Sir George) Birdwood, whose name is so closely identified with the working of this Society, should also be noticed. Ever since the publication in 1865 of his valuable work on the "Economic Vegetable Products of the Bombay Presidency," scarcely a year or even a month has elapsed without his making a fresh contribution to this ever-expanding subject. Subsequently, during the term of Lord Reay's office as Governor of Bombay, attention was particularly drawn to the important subject, and great enthusiasm was developed, especially through the personal efforts of his lordship. The Victoria Jubilee Technical Institute was established in Bombay, and was followed by a similar institution, in Baroda, the Kala Bhavan, which owed its existence to the exertions of H.H. the Gaekwar, and which flourished for some time under the guidance of Prof. T. K. Gajjar, who is so well-known in connection with the restoration of the late Queen's statue in Bombay. A few industrial and art exhibitions were organised. Through the efforts of that eminent man, the late Hon. Mr. Justice M. G. Ranade, annual industrial conferences were held to discuss the important subject of reviving old and introducing new industries. Everyone seemed to appreciate the full importance of the subject, and great results were expected ; but somehow the interest gradually cooled down and work slackened. India could not remain in this lethargic mood for any long time, the subject being so vital, involving the very existence of the country. Sir M. M. Bhownaggree, to whose strenuous efforts our hearty thanks are due, gave a fresh impetus to the gradually languishing movement. Most of us are now beginning to realise the practical importance of the subject, which is occupying the attention of all classes, creeds, and nationalities of the people and the Government of India alike. Politicians, merchants, educationists, philanthropists, scientists, all unanimously advocate the necessity of industrial progress before everything else. The younger blood is warmed with a desire to bear the yoke and be the pioneers in the field ; the thoughtful are busy devising new schemes ; the rich offer benefactions, and the Government is employing various agencies to find out the best means to bring about the desired end. In short, there is enormous enthusiasm growing up in the country in connection with this subject. Scholarships have been established by Universities and by the Native States of India, to send Indian youths to Europe for industrial education. We all know the munificent offer of Mr. J. N. Tata, towards the establishment of a research university. It is, therefore, prudent and indeed imperative to decide upon and shape our future course, and guide the rising tide of activity, to prevent unnecessary waste or fruitless effort. I must admit that this subject is attended with one great difficulty ; I refer to the want of a good and organised opposition, which in modern times is a potent means to bring about success. Because there is no difference of opinion, no bitter controversies and conflicts, this subject has to be shelved in order to discuss the more contentious ones. What, therefore, is admitted to be everybody's interest, has become nobody's business.

To-day our position is one of great responsibility. We have to lay the foundation-stone of a great edifice on which will rest the destiny of a rising nation, constituting one-sixth of the whole human race. We should scheme well and plan well. We must study the different methods employed by other nations, especially those of the West, and examine their present progress, in order that we may avoid the pitfalls in our way and adopt what would best suit our requirements.*

The first thing we have to do is to define our aim in unmistakable terms, and to keep it distinctly in view throughout all our efforts. What sort of industrial progress should we try to attain? It is said that India ought to be able to produce every article which is required for the consumption or use of all her inhabitants so that her internal intercourse may go on without the slightest interruption even though she be cut off from all other parts of the world; that she should jealously avoid foreign imports, and that she should assiduously try to increase her exports. This is a doctrine which is still held by some to be advantageous even for countries in this part of the globe; but it has been proved to be perfectly erroneous. It makes rivals of nations instead of friendly associates, and, as universal history testifies, poverty, degradation and enslavement follow as the consequences of such rivalry. Nature affords a guide in this case. All our efforts, methods and aims must be in conformity with the laws or uniformities of nature, in order that the results may be good and lasting. That is the great test according to which mankind must rise or fall. We see countries in different latitudes, with different climates, and with endless diversities in their natural surroundings, and it is absurd to say that every article can be produced with equal excellence and economy under all these diverse conditions. There are also the differences in physical and mental powers of different nations which give different degrees of aptitude in producing different articles. Still more important is the difference that arises from the development of special skill. If there are ten men and ten professions, each man trying to learn all the ten professions will be worse off than each taking up one profession. What is true of individuals is true of communities, and also of nations. It is, therefore, evident that every nation should concentrate its attention on the production of those articles which its surroundings permit to be produced most profitably or by least labour, and acquire in exchange by trade the rest of the articles it may want. This will bring about a decided increase in the production and excellence of goods, and lead to diminished cost. For example, it is said that the dry atmosphere and the inferiority of the raw material makes it impossible to produce the finer qualities of yarn in the cotton mills of Bombay. Attempts were made to grow tobacco in Gujrât a few years ago, and the tobacco produced was found to emit an intolerable stench. Efforts were made to get rid of this without much effect. It was even kept in port wine for a long time so that the smell of the latter may overcome that of the tobacco; but it contracted two bad smells instead, one of its own and the other of port wine. If this be true it would seem advisable to utilise our energies in establishing some other new industries which may be more profitable and more suited to our climatic conditions. Though this precaution seems to be necessary against wasting our resources on impossible or unprofitable enterprises, we may still be always sure that the greater portion of the manufactured goods which a country requires can always be supplied at home.

There is one more point pertaining to the general science of political economy to be considered in relation to the industrial progress of India. That is a subject on which Indian opinion is divided. Should India adopt Protection in order to foster its own industries? Most of the Indian scholars, administrators, and legislators accept the scientific truths and doctrines of Free Trade. Although our sister colonies have not yet fully admitted the claims of this principle, and though one can hear dissenting voices even in Great Britain, and still more in the United States, it may be safely said of India that Protection pure and simple is never contemplated in our commercial policy. But there seems to be a feeling in favour of making an exception in case of what are called the "infant industries." Some Indians of note, such as the late Mr. K. T. Telang and the late Mr. M. G. Ranade, both men of sound judgment, were inclined to protect the nascent industries, at least temporarily, and until they grew strong enough to join the struggle. This view is admitted by John Stuart Mill, who writes: — "The only case in which on mere principles of political economy, protecting duties can be defensible, is when they are imposed temporarily (especially in a young and rising nation) in hopes of naturalising a foreign industry, in itself perfectly suitable to the circumstances of the country." As a matter of theory, one must accept the truth of the above doctrine. It is true that industries capable of being most profitable and highly developed, have often to labour under great difficulties, nay remain crushed for ever, merely on account of their having been introduced in another country a few years before, and no doubt a well-guarded measure of that sort may tend to a good result. But protecting an infant industry, means profiting a section at the sacrifice of the community at large, and if it is certain that this initial sacrifice made by the community will be rewarded by the numerous advantages arising from the permanent establishment of a new industry, the sacrifice is, no doubt, justifiable. But who is so omniscient amongst men that he can say that such and such an industry is sure to thrive in any country? This suitability cannot be decided on the scientific grounds of raw material, labour, climate, and such other obvious causes; something more is required, something that is not quite perceptible to our faculties, to explain why the peculiar produce of one country cannot be equalled by that of the other. Danish butter, Spanish wines, Chinese silks, Indian brass, and Dacca muslin are still unbeaten. Paisley failed to produce Cashmere shawls. In India itself there are certain places which excel all others for colours on wood, colours on stone, and colours on glass. In one and the same industry, again, as for example, in weaving of different sorts, there are places which cannot be surpassed by others, although rivalry has been attempted not a few times. To take an instance, some weavers in Dharwar District tried to imitate the silk weaving of Benares; they failed miserably in their object, but in these efforts developed another kind of silk weaving, for which Dharwar is now well known.

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* "Many a vague idea is now floating in the air which requires to be definitely formulated, and many crude and ill-digested recommendations need to be put into the crucible of the practical with a view to being thoroughly tested before we can all agree upon a common basis on which a fair attempt at industrial development might be made." —Presidential address of Mr. Dinshaw Edulji Wacha at the Indian National Congress, 1901.

But apart from this question of suitability or unsuitability, we have to consider how long it will take an infant industry to grow into manhood. Some think it takes the lifetime of two generations to establish a new manufacture in a country.* It, therefore, remains an open question whether it would be advisable to tax the whole community for so long a period in order to introduce a new industry, whose chances of success are doubtful, or, at the best, only probable. Besides, there is the additional uncertainty arising from the fact that the industries of one generation are not always the industries of the next. Like other things, they have to change with the times.

But now it may be asked whether Protection is the only effective means of fostering a new industry. Are there or are there not other methods equally powerful by which a new industry may be encouraged without incurring the evil effects of Protection? I believe subsidies, bounties, free gifts of land, suitable legislation, facilities in transmission and sale would do more good to a new and rising industry than Protection. The belief, for example, that the import of bounty-fed sugar brought about the decline of the indigenous industry in India led to the recent imposition of Protective duties on that article. I am unable to say that the diagnosis was quite accurate, as the remedy applied seems to have failed to bring about the desired restoration. Is it not the fact that the decline of the sugar industry began long before the introduction of the bounty-fed sugar, and was this not due to the difficulty caused by some regulations of the Abkari Department preventing private proprietors of refineries utilising or profitably disposing of the non-crystalline by-product of sugar? This was at least true of a private concern started in Poona a few years ago. Here, therefore, is an opportunity to see whether a little liberty or facility which an enterprising man may justly expect, would not bring about a result which Protection failed to do. It may be mentioned here that in the opinion of some it is sound policy to allow few concessions, to invite new enterprise, and then give all competitors "fair field and no favour." Then will ensue a general "scrimmage" which will eliminate those industries which are too weak to be rooted in the soil. Attention, then, may be directed towards the fittest who survive. Special favours do more harm than good. They lead to a scramble in which it is the strong not the weak, the unscrupulous not the deserving, who get the most of the benefit.

Judged from every point of view, we find agriculture to be the greatest and most important industry of India. India is the home of agriculture, and has been from ancient times the granary of the Old World. It has always employed the largest number of the inhabitants, and even at the present time claims nearly 85 per cent. of the population of the country. In the consideration of different industries, agriculture, therefore, claims the first place. Whatever may be thought by others, I am inclined to believe that this excessive dependence on agriculture alone, has been the weakest point of Asiatic civilisation. It has been an old inheritance, and the evil has been greatly aggravated by modern influences. Notwithstanding the enormous amount of money spent by the Government of India on railways and canals, as well as in pioneering efforts to diversify the occupations and pursuits of the people, we find during the last decade dependence on soil, which is already exhausted by over-cultivation, has increased from 59 to 85 per cent. of the total population. Remarkable is the contrast of this increasing agricultural class with the decreasing area under cultivation, from 194,414,057 acres in 1890-91, to 180,157,093 acres in 1899-1900. The following Table will show the variation in the area under cultivation during the last decade :—

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* "It will ordinarily take the lifetime of two generations to acclimatize thoroughly a new manufacture, and bring the native production up to the native demand." "Political Economy," by Professor Thompson, University of Pennsylvania.

Cultivation.	Acres in 1890–91.	Acres in 1899–1900.
Food grains ..	176,584,473	164,878,795
Sugar cane ..	2,793,690	2,693,029
Coffee	133,016	132,565
Tea	335,605	493,187
Oil seeds	11,586,842	10,327,641
Cotton	10,968,789	8,375,841
Jute	2,479,504	2,070,668
Indigo	1,215,000	1,046,434
Tobacco......	133,016	915,321

The condition of our agricultural classes, whether it is improving or not, has been recently a matter of keen controversy amongst statesmen who are conversant with Indian politics, a controversy which we need not here repeat. From personal experience and facts we have observed, we may venture to believe that the poverty of the agricultural classes of India is not only chronic and increasing, but is becoming a source of danger. The people have forgotten the ancient methods of agriculture, without substituting the modern methods. They are using the implements to-day, which their forefathers used perhaps a thousand or 2,000 years ago. It is most inexplicable that India, which is an entirely agricultural country, should not only not import manure and latest agricultural implements from foreign countries, but should actually export the former commodity annually more than 100,000 cwts., and nearly a crore of rupees worth in price. What the people badly need, is education in the science and methods of agriculture, such as manuring, diversification of seeds, &c., and help, financial and administrative, in raising the quality of their produce. It is a matter of great satisfaction to know that the subject of agricultural banks is occupying the attention of the Government of India. If these banks are to be taken up by the State as the landlord, it will have to be seen how far the State will co-operate with the peasant, and avoid "red tape." If private enterprise or co-operation is brought into use, the success will more or less depend upon the morality and honesty of the agricultural classes. Low interest presupposes elimination of bad debts. There are many cases where people willingly pay their fathers' debts, which law could not enforce. On the other hand, it must be noted that the old belief that if a man dies without paying his debts, he will have to be a dog, and watch the door of his creditors' house in the following birth, is gradually vanishing.

It may now be worth our while to examine other methods used by other European nations in the neighbourhood of India, under similar conditions. The scheme employed by the Dutch, in the Dutch East Indies, is worthy of our consideration. The Netherlands' possessions in the East Indies cover an area of 30,000 square miles, and contained a population of about 30,000,000 in 1885. In 1833, the gross revenue amounted to 30,000,000 florins, or two crores of rupees. But up to this time the expenditure of the State exceeded the revenue by 1,000,000 florins annually, and General Von der Bosch, then Governor of the islands, felt the pressing need for the development of the resources of the possessions. The plan he introduced in 1833, and which was in operation until more than thirty years after, is known as the Culture System. It may be remarked that before the advent of European control there was practically very little difference in the customs, manners, habits, the government, and occupations of the people of these islands and those of India. Subsequently, the Dutch Government followed a radically different system in their possessions than the one followed by the British in India. The latter were founded on modern ideas of equality, and though more favourable in its educating influence on the people, adopted a much larger foreign agency, requiring checks upon checks, and a hierarchy of officials, rendering it heavy in cost. The Dutch system was more protective of the native model of government, and adopted foreign agency only for the work of inspection, and report, and management of coast towns, consequently, was cheaper, and did not dismember the native society to the same extent as the other does in India. The aim of the culture system was to fertilise waste lands, and bring out the hidden resources of the country. Advances, not exceeding 200,000 florins, or about £14,000, were made by the Government to contractors of high respectability, intelligence, and enterprise, for initial expenditure, to start a planting or manufacturing concern. Land which was not used for growing rice for the subsistence of the cultivators, was given free of rent. There was official superintendence to see that the money was being properly utilised for the object proposed, and official help was given in all expert knowledge in choosing the site, selecting and buying the machinery, and fitting up and working the concern. Machinery could be imported free of duty, and timber and other materials from the Government forests were also supplied free. In addition to this initial advance, which was to be repaid, free of interest, in ten yearly instalments, beginning from the third year, a yearly advance for the production or manufacture of crops was made, which was to be repaid during the same year out of the produce, either in cash or kind. The Government generally took 2-3rds of the produce in payment of this annual advance, and, disposing of it in European markets, made a profit for themselves. From the remaining 1-3rd, 1-10th of the initial advance was deducted, and the rest was the profit to be divided between the contractor and the cultivators. There were other regulations which procured forced labour and cultivation of the private farms of the contractors, which is beside our present inquiry, and need not be entered into here.

The success that attended this system has been recorded in an official report submitted to Lord Dufferin by Von Berg, the Governor of Java in 1885. In 1871 there were 99 Government contractors, who planted 70,000 acres with sugar-cane, employing 225,000 labourers. The surplus of revenue amounted to 52 crores of rupees between 1831 and 1871, without any public debt. Sugar-cane, indigo, tea, tobacco, cochineal, coffee, cinnamon, and pepper were produced in large quantities under this system. The official superintendence was paid by a small percentage charged on the produce.

The Government of India on its part has not been altogether inactive in this direction. The pioneering effort made by them helped to bring thousands of acres of land into tea and coffee cultivation. Advances were made to the peasants as Tagai; and although such advances in the past were so few that they could reasonably be ignored, their necessity and extension has been recently emphasised a good deal. Experimental farms were opened in different provinces to test the cotton, tea, tobacco, coffee, cinchona, and other plantations; but it must be remarked that such attempts were more or less desultory, and wanting in the thread of continuity, which would have ensured better results. The opium farming, which is worked under a system similar to the culture system, has been most beneficial, and brings a considerable reveue. It rose from Rs. 83,84,500 in 1834-5, to 4,01,22,417 in 1899-1900. I do not think that any one who knows the present condition of the people of India will advocate the culture system, as it was adopted in Dutch India, for British India. But it may be noticed that the peculiar feature of success of this system over the independent plantations and other enterprises is, that it utilised the public credit in getting capital on low interest, and it gave the ignorant labourers expert advice and effective superintendence. The Government of India has not been slow, also, to adopt the above principle, as we see its tacit admission in the railway policy and the opium farming. If the scheme has been successful, where it has hitherto been adopted, there is no reason why Provincial Governments should not be authorised to extend it systematically on a large scale in growing higher kinds of produce in different provinces. The advancement of the latter seems to me a matter of more interest than the construction of railways, which no doubt has its own benefits in politica and military advantages. It may, to a certain extent revive the local indigenous industries of India, which, as a matter of fact, have been, except in the Presidency towns, destroyed by the railways, serviceable though the latter are in bringing speedy relief in times of famine. The Government being landlord and sovereign, has a right and is under corresponding obligation to undertake functions which will lead to public advantage.* Cheap capital, expert advice, good and kindly superintendence are the pressing needs of the population, and these objects deserve our first and closest attention.

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* "A good Government will give all its aid in such a shape as to encourage and nurture any rudiments it may find of a spirit of individual exertion. It will be assiduous in removing obstacles and discouragements to voluntary enterprise, and in giving whatever facilities and whatever direction and guidance may be necessary. Its pecuniary means will be applied when practicable in aid of private efforts rather than in supersession of them, and it will call into play its machinery of

Now, we come to the consideration of the secondary, or the manufacturing industries. As an Indian, I cannot approach this subject without a pang of heart, when I bring to my mind what admirable skill and what special handicrafts are lost to-day, not only to India, but also to the world. The finest Dacca muslins, Cashmere shawls, Bengal silks, Agra marbles, and many other artistic productions too numerous to mention, are all gone, and the arts concerned are about to disappear from the stock of human accomplishments. The famous iron pillar near Delhi, which is estimated to be at least 1,500 years old, demonstrates the amount of Indian skill in the manufacture of wrought iron. Mr. Ball, an officer of the Geological Survey, admitted that it was not many years since the production of such a pillar would have been an impossibility in the largest factories in the world, and at the present day there may be but very few factories where such a mass of metal could be formed. Cannons were manufactured in Assam of the largest calibre. Indian wootz or steel furnished the material out of which Damascus blades, with a world-wide reputation, were made, and it paid Persian merchants in those old times to travel all the way to India to obtain these materials, and export them over Asia. The Indian steel found once considerable demand for cutlery, and is even now respected in this country. The same may be said of shipbuilding, calicoes, pottery, glass, lacquer-ware, mattings, carving, and dyes of various sorts. A few typical examples may be of interest.

When, in 1817, an Indian ship, laden with Indian products, sailed into the Thames, it caused such an alarm in this country, that ridiculous duties, varying up to 622 per cent., were levied on Indian imports. I refer to this only to show how thriving were our industries, and how we dared to outstrip Britain in her own market. Alas! what do we find at present? Disappearance of all old industries, and a rush for agriculture, in spite of all the efforts of the Government and the people alike. Why it should be so, is a problem for the consideration of statesmen. That manual power should make way for mechanical agencies does not seem to be an adequate explanation. We have yet to discover why it is that, in this present time of progress, industries are impaired, and the social system broken into.

A few years ago, an Indian prince desirous of sending a present of a Cashmere shawl to our late beloved sovereign, the Empress of India, despatched three of his officers to travel all over that country to get one of the very best, worth about, at least, a thousand pounds. Strange to say, the officers, after a most laborious and earnest search, could not get one worth more than £40. When these shawl-makers were brought to the Palace, and when the Prince expressed his surprise at learning that shawls could not be made worth more than about £40, while he had in his possession, for a good many years, shawls, some of them worth nearly 30,000 rupees, or £2,000 each, one of them replied that the shawls in the Palace were made twenty or thirty years before. At that time, the demand of the rich and middle-classes was supplied by Cashmere, and, as a consequence, the industry was progressing, and skill was advancing by competition. But now the wants of the middle classes are supplied by the worthless and cheap imitations of the West, while the orders of the palaces and the rich go to the costliest and most celebrated tailors of London and Paris. The art, he pathetically added, is lost, and lost for ever.

Recently an American friend of mine, a great lover of Indian art, having studied it in books for years, paid, at last, a visit to that country a year ago. He had easy access to the palaces of princes and the mansions of the rich. He was most courteously received everywhere, and all the grandeur of palaces was exposed to his view. My friend wrote that the palaces were museums of Western articles, for which high prices must have been paid; the furniture, the curtains, the lamps, the carpets and everything was of the latest European make, and perhaps the finest that Europe could produce. But when he asked whether there was any Indian art furniture in the palace, he was taken to a back room where he saw some priceless treasures of human skill carelessly put together, and some of them badly suffering from want of care. Alas! he cried, for the ill-fated arts of India.

In the place of the old industries, we

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rewards and honours to elicit such efforts. Government aid when given merely in default of private enterprise should be so given as to be as far as possible a course of education to the people. Government must undertake to do the things which are made incumbent upon it by the helplessness of the public in such a manner as shall tend, not to increase and perpetuate, but correct this helplessness."—Mill's "Political Economy."

can see some new ones, such as tea, tobacco, jute, &c. But these, as Mr. Baines tells us, "are in the hands of Europeans, so that only the price of the labour remains in the country." Whereas the older industries benefited the masses of India, the new ones can but give employment to very few, as we see that pressure on land is every year frightfully increasing. The time has arrived for drastic measures.

Mr. Baines, in his thoughtful paper on this subject, made the following statement:—"Indian society being what it is, it is hardly to be expected that its industrial quickening will be effected by the outward application of direct stimulus, either in the shape of instruction, or, more insidiously, by State dry-nursing." Though I readily repeat what I have expressed before, namely, my great admiration of Mr. Baines's paper, I cannot bring myself to accept the truth of the statement I have quoted. In fact I stand at the opposite pole in this connection. Mr. Baines's view chills all energy and hope, and drives us towards despair. It savours of fatalism, which Mr. Baines, during his long stay in India, seems to have been infected with. It is true that when reforms come from within, they grow on a wider and a firmer base, and the result is good and permanent. But this belief presupposes an internal irrepressible and constantly growing vitality in the community. Do we find any evidence of this in the Indian community? Do we see any of the followers of the shawl and muslin or any other ancient industries attempting to resist decay of the art either by co-operation of individuals or by adapting their products to the modern requirements? No; they succumb without murmur and swell the ranks of the agriculturists. With regard to new industries, do we see any attempts, either successful or futile, made by the millions of people who, in times of famine, foresee the shadow of death growing over them? They seem to make no struggle, not even by theft and burglaries in such crises of life and death, but give in to the inevitable without the slightest resistance. How can reform come from within, in such a community? We may deprive a naughty but healthy boy of his meal, to induce his reform from within, but will the same treatment be effective in the case of an obstinate patient, who is very nearly at the stage of collapse?

I entirely disagree from Mr. Baines's diagnosis of the Indian community. The Indian civilisation has not grown in its own narrow groove. India, undoubtedly, had its own civilisation, but that was progressive. It advanced with the times. Instead of resisting, it always welcomed such foreign innovations as suited its constitution, and fostered them as its own. If we analyse and minutely examine that complex phenomenon, we shall find in it distinctive traces of Egyptian, Persian, Saracenic, Chinese, Japanese, nay, even, Greek and Roman civilisations, not only in industries and arts, but also in literature, poetry, philosophy, religion, music, and all other sciences, well digested and embodied in one compact system. Even at the present day it is admirable how it can absorb Western ideas, so different from its own, in every branch of human activity, *e.g.*, industrial, literary, social, domestic, and even in adapting the Christian tenets to Hindoo religions. There has been always a suitable response only when approached in the proper way. The door is always open to those who know how to enter it. The great Moghul Emperor, Akbar, knew it, and brought about an everlasting union between Hindoos and Mohammedans, induced even intermarriages between the two communities, an evidence of natural bond and kinmanship. Our present rulers ought to know it, and until they know it, to use Mr. Baines's words, "all else beats at the door in vain."

Let us now examine the condition of some of our neighbours who belong to the same mental group, and lived under similar institutions, and now have bettered their national condition. I have already drawn attention to the culture system adopted in Dutch India and the success that attended it. Japan is another Asiatic country which about forty or fifty years ago was engaged in a civil war, and was as backward as any in the East. We all know how she developed her resources during such a short time, and has now become a supreme power in Asia. I need not apologise for bringing in this comparison, as it is frequently said "Look at Japan, how she thrived. Why cannot India do the same?" At least, I put the question to myself very often, and sought the kind help of a distinguished Japanese statesman in London and Principal H. Dyer, who can claim a joint authorship of the industrial prosperity of Japan, in the solution of the question.

Let me revert for a moment to "the reform from within" theory, as I see some people often fail to perceive the right meaning of the expression. Perhaps no one will object to my saying that Japan developed its resources from "within." The words "from within" here mean by the joint efforts or co-operation of the Japanese Government and the Japanese people. But when it is said in India that the development must come from within, the word is used as if only meaning "within the people," and independently of the Government of India. It is asserted as if the resources of the Government of India did not belong to the people; as if the monopolies of land, &c., enjoyed by the Government of India are not for the benefit of the people; and as if the revenue collected from the people was a sort of tribute to be paid to foreigners who had nothing in common with the country, and in which the inhabitants of the soil have no claim whatever. I maintain, the resources of the Government of India belong as much to the people as their own. So far as we seek to utilise these resources for the benefit of the country, and seek no help from the home Government, or the French, American, or Japanese Government, we are strictly trying to do everything from within and not from without.

When the civil war was ended in the early sixties, and when all the ports were opened later on, Japan felt the need of developing its resources, and the work was commenced at once. They began to send Japanese students to learn industries all over Europe and America, until the number reached a few hundreds. This being found expensive, Japan learned to bring specialists of various professions and trades from abroad to teach Japanese youths at home. The services of men of the widest reputation in the United Kingdom, such as Messrs. H. Dyer, John Perry, &c., were engaged, and at great expense to the State a college was established ostensibly to prepare engineers for State service, but Principal Dyer adds in his report, submitted four years after the organisation of the College, to H.E. Marquis Ito, then Minister of Public Works, that "the word 'engineer' is to be taken in a somewhat wider sense than that in ordinary use, so that the problem before us, practically, was to draw out a scheme of technical education, to include everything that is required to enable Japan to occupy her proper place among the manufacturing nations of the world." At first classes were opened to teach those arts and sciences of which the need was most felt, and gradually more were added. A grand technological laboratory, a technical museum, and a technical library were attached to the institution, and the college which was founded in 1873 has remained to this day true to its faith. Thus began the auspicious work of erecting the pillars of the present Japanese civilisation. The work of the college did not stop at the graduating of its students, as such work unfortunately does in India, but the native talent thus trained was at once given an opportunity to combine theory with practice, by being entrusted with work either in railways, mining, lighthouse, telegraph, different manufacturing departments, or engineering work, which are all the property of the Government. The plan which was submitted by Principal Dyer to the Government of Japan in 1877, for the advancement of manufactures, I may give in his own words:—

> "In Europe or America it is sufficient to educate the students at college as generally there are opportunities for him applying his knowledge, but in Japan the circumstances are entirely different. As I have already mentioned, almost all the engineering works are under your care in the public works department, and my experience during the last four years has been sufficient to show me, that under present circumstances, unless the Government undertake comparatively large works they will remain undone. This is only to be expected from the previous social and political conditions of the people, as enterprise of every kind was discouraged, and combination for any useful work entirely unknown. Japan is by no means a rich country, that is to say, there are no stores of accumulated wealth, and, in my opinion, does not possess sufficient capital to open up its resources in a reasonable time, but the want of faith which the people display in industrial enterprises prevents what money is in the country from being usefully employed. Till, therefore, confidence has been established in the practicability of such works it will be necessary for the Government to take the lead and give such assistance as may be necessary, taking care, however, to give it in such a way as really to encourage private enterprise. The business of life is essentially the practical education, in which everyone should be left as far as possible to exercise his own judgment, discretion and skill, as the self reliance produced by these qualities is of the utmost importance in forming the character of a nation."

This plan, it may be remarked, was rigorously followed. The Government undertook new manufactures, and when they were well established handed them over to private hands. At first the Government of Japan was compelled to employ foreign agency in working their railways and workshops, which, though unavoidable, was found to be very costly, but as the native talent became available, as trained under the foreign specialists, the foreign agency was limited only to supervision. This resulted in the Japanese railways being more cheaply managed, and yielding 7 or 8 per cent. dividend on the capital employed.

Laws in respect of foreigners were relaxed, and thus foreign capital gradually entered the country, and worked jointly with the small capital of the people of Japan, and while a fair rate of dividends went out, a greater proportion of profits remained in the country, and added to its resources. All other works flourished in like manner. If India would succeed like Japan, India must do what Japan did.

Only two points may be noticed before the comparison is considered complete. In Japan, the language and laws of State are Japanese, which only the people of Japan know fully well. This makes it compulsory to a great extent for foreign capital to enter into partnership with native intellect, and share the profits in every new enterprise. In India the case is different. The machinery of Government, and most of the laws governing commercial relations and the language of the State being English, a Britisher or an American can directly and more easily communicate with the Government of India and enjoy its co-operation than the Indian himself. Combined with this are advantages originating from the sameness of ideas, habits, and manners, which smooths the way of the Britisher or an American, and even any European, to enjoy the confidence and patronage of the Government of India, to the exclusion of the backward, ignorant, and unenterprising Indian. The tea, coffee, tobacco, and steel and iron industries, in pioneering which a large amount of the taxes of the Indian people were spent, have thus passed into foreign hands. If equality of opportunities to all, and no preference to Indian capital and enterprise, is pleaded as an argument, it will be like offering the same meal-tub to infant pigs with the full-grown swine.

The other point to be considered is, whether it would be right and advisable to adopt the Japanese method literally, and hand over such concerns begun by Government even to the enterprising Indians themselves. The money spent in the pioneering work belonged to the whole of the revenue-paying masses of India, and it is a question how far one will be justified in using their money in making a few people rich. It must be remembered that the first object we seek by industrial development is to bring relief to the millions who die of starvation in times of famine, and not to enrich a small section. Concentration of wealth in the hands of a few Indians, Britishers or foreigners, makes but little difference in the fates of the millions of those whose struggle for existence is becoming harder every day. Our programme, therefore, must be arranged in such a manner as to give the greatest benefit of our efforts to the masses of the people who are in most need of it.

Now the way is to a certain extent paved for the consideration of a plan for the industrial development of India. Let us proceed to examine the different remedies proposed and advocated by those who have preceded us in the field. It is asserted that the only remedy is the admission of Indians into the higher services of India and to lessen the costly foreign agency, and thus allow the capital of the nation to accumulate for stimulating her industrial progress. Though I have my own differences and agreements in connection with the above view, the inquiry of this subject falls under the head of politics, and being, therefore, alien to the subject of discussion, I cannot find room for it in this paper. The first place, therefere, must be given to our friend, Sir Mancherjee Bhownaggree, who has for the last few years devoted his energies exclusively to this subject inside and outside the House of Commons. It is a pity that we have not yet been favoured by Sir Mancherjee with a scheme of his own, well drawn in all its details, from the start to the end. All that I can make out from his speeches and writings is, that he trusts to the development of the tastes and talents of the people by education, to bring about the desired end. Before a similar meeting of this learned Society, he stated that "the first step in this direction was to attach to all schools throughout the country, from village schools to high schools, workshops, laboratories, and other agencies for imparting technical instruction. Many schools in England, and, perhaps, a larger number on the Continent, had their technical classes, and if like means were supplied to our Indian schools on a scale in proportion to the size and capacity of each, it would be found that large bodies of students from young age would acquire a taste, as they would have thus the opportunity for developing the talent which they undoubtedly possessed for different industries." The question of technical instruction deserves our greatest attention, and much more importance clings to it, especially since we heard the Right Hon. Lord George Hamilton making a most encouraging promise from this platform, only a few days ago, that as the condition of finances of India were highly encouraging, he would devote part of the surplus to industrial education.

It is much to be regretted that the subject of technical education has been so much entangled with primary and secondary education, that it seems difficult to assign each its proper place. The vastness and importance of the subject demands a separate and independent paper for itself. Nobody has ever doubted the necessity of higher education. It is essential, and perhaps more useful in preserving the life of a nation from decrepitude and decay, diseases common to individuals and States. The difference of opinion, therefore, lies in the question as to which should have precedence, the higher, or the technical education? I cannot resist the temptation to quote a few lines from the report of 1877, already referred to, of Principal Dyer, who moulded the prosperity of Japan, and set an example to all Asiatic nations. They seem to me most fitly applicable to the case of India.

> "I have a most decided opinion that a man who has a thorough knowledge of some manufacturing art is likely to be a better citizen than one who fritters away his time dreaming of the works of Herbert Spencer, John Stuart Mill, or Buckle, as is often the case with Japanese students. A student who has been kept strictly to his duty for six years, and who knows how to apply his knowledge, is likely to turn out a more moral man than one who is stuffed full of rhetoric and moral philosophy. The Chinese have always been great students of moral philosophy, but it does not seem to have had any good effect on their morality . . . . In Japan at the present moment I think it is essential that education should not be looked upon as an end, but as a means of enabling a man to do his duty in his journey through life. Unless this is done the education he receives simply unfits him for his former position, he will not turn to manual labour, but will become a discontented member of society, converting such shallow instruction as he has received into a means of embarrassing the Government by writing articles in the newspapers on subjects with which he is incompetent to deal."

To my mind this question seems to be simple enough. If we analyse human conditions, we find that the first thing we have to do is to satisfy our physical cravings, and when these are more or less satisfied, arise the cravings of the mind. Nature, therefore, gives precedence to the satisfaction of physical cravings over mental luxuries. This evidently brings us to what Mr. Froude said: "Human life is action and not speculation. The first essential of education is to teach men to earn their own living."

There is no doubt that education conveyed to the people in any form and manner will always bring about some good, but we have to consider whether the technical classes universally attached to schools and colleges, which Sir Mancherjee Bhownaggree proposes, would be more beneficial than a central institute for the whole of India as advocated by Professor Wyndham Dunstan, a few days ago on this platform. The latter scheme finds favour with another eminent man of science, who most combines scientific knowledge with practical experience—I mean Professor William Ramsay, who has rendered most valuable help to India in outlining a scheme for the Research University, which is proposed to be started out of the munificent benefaction offered to the people by Mr. N. Tata. No doubt it seems much more advisable to have a central institution, where students can devote all their time to the theory and practice of particular branches of manufacture, than to diffuse our energy and resources in elementary show all over the country. An institution where a student would receive not only the necessary technical instruction but where he might be able to start a small experimental factory and pay the most rigid attention not only to the details of the manufacture but also to the general organisation and manufacture of the business, is our want; and in my opinion none better can be found than the one sketched by Professor Ramsay for Mr. Tata. With us there is the difficulty as to how much money the Government of India can spare for such an object. Taking, therefore, all things into consideration, the best course for us will be to induce the Government of India to meet Mr. Tata half-way and afford him every possible facility in starting the long-looked for Research Institute according to Professor Ramsay's scheme. I hear that a demand of £5,000 per year is made from the Government exchequer, and if the scheme falls to the ground only through the non-satisfaction of this demand in spite of cheerful finances, the Government of India may well be blamed.

As for Sir Mancherjee Bhownaggree's idea of the development of skill in India, it must be remarked that there is enough skill in the country. Indian artisans are more skilful, more subtle in their manipulation, more sober in their habits, more steady and manageable than any in the world. A blacksmith at Málvan, in Ratnagiri district, made razors and knives which could not be distinguished from the best of Sheffield. Give a model of any sort to the silversmiths of Kutch, and they produce the duplicate without difficulty. But what our people lack is the faculty of co-operating and organising, the power of managing, attention to details, financing, and pushing their goods in the markets of the world. A Western article in India represents skill combined with all the above-mentioned advantages, but an Indian curio means only the skill of the worker, and nothing else. As for Sir Mancherjee Bhownaggree's idea of giving the Indian youths a taste for industries, it may be observed that the best way to accomplish this end is to make their occupations profitable. The taste of any business that pays is always very nice.

Another proposal which finds favour in some quarters is to take experts, engineers, and capable men from Europe to India, and start different manufactures under their direction and supervision. This experiment has been tried with varied results. Where a large capital has been accumulated, and where one or more experts have been taken over, in each branch of a particular manufacture, the experiment has been successful. The cotton and jute industries, the breweries, and leather industries can be said to have advanced under the above method. But it must be remembered that in such cases the raw material these foreign experts had to deal with, was already known to them. It, therefore, becomes difficult to judge whether the same good results would follow in the case of a manufacture where the experts have to deal with different raw materials and among local conditions quite new to them. Besides such a scheme requires an enormous accumulation of capital, which is not an easy thing in India. Where small capitalists have started small works and where one expert was taken over to work in various branches of a manufacture the experiment has invariably proved a failure. The glass factories at Ahmedabad and Umballa and many other instances could be cited. And then what generally happens is that these first-class experts imported to India turn out to be fourth-rate men. The best men in any trade earn comfortable wages in this country, and do not care to leave their happy firesides to go to a country where snakes, mosquitoes, dust-storms, and sunstrokes prevail.

As a counterpart of this it is proposed to send Indian students abroad to study different manufactures and utilise their services on their return. With certain precautions and under proper regulation this seems to be a good plan and likely to be most beneficial to the country. Selection must be made with the greatest care from students of superior culture, who have thoroughly mastered the theory and science of a particular manufacture, and who have also made themselves conversant with the local conditions for the same. Let them be sent to Europe, not to join a university, school, or college, but to work—to work with the workmen in a factory, and go through every detail of the factory work, including the management, both factorial and commercial. The belief that

> "We are the boys who scorn to soil
> Our lily hands with dirty toil,"

can no more be sustained. The student whose discretion can be trusted, may be under general superintendence, but free from petty interferences, and his work may be judged by the results. The student will realise his responsibility that it is late to begin any other occupation, that he has to fight his battle of life on the lines he has accepted, and when he goes back he may be able to induce his friends, relations, and those whom he can influence—especially if he goes in for small industries—to collect a small capital wherewith he may begin his honest and good work. But this cannot be achieved if the student is sent on £100 a year, and is asked to struggle as best he may, in a foreign country. The Government of India, which sends three students every year to the universities of Great Britain, may take the initiative in this auspicious year of finance to send an equal number of students to Europe for industrial education. The students have a brilliant field before them, as can be seen from the following Table of exports and imports (p. 346).

We may now compare the Table showing the values of raw materials exported, with the Table which shows the values of goods manufactured from those very materials which we receive back again in the form of imports. Thus raw cotton is exported to the value of Rs.99,000,000, while the manufactured cotton goods imported amount to Rs.294,000,000; raw wool exported Rs.18,000,000, against manufactured woollen goods imported Rs.15,000,000; raw silk exported Rs.70,000,000, against manufactured silk goods Rs.11,000,000; oil seeds exported Rs.100,000,000, against only Rs.2,000,000 imported, in the form of oils. These instances need not be here multiplied; they suffice to show hat India can furnish both raw produce and markets for the corresponding manufactured article. Considering, therefore, the freights to be paid both ways and the high wages of Europe, there is ample field for the highly profitable introduction of these manufacturing industries in India.

EXPORTS.

Article.	In 1879-80. Value in Rupees.	In 1889-90. Value in Rupees.	In 1899-1900. Value in Rupees.
Coffee	16,330,320	15,000,080	15,058,487
Coir	171,101	2,476,522	3,888,894
Cotton (Raw)	111,454,530	186,713,290	99,250,752
Drugs	2,022,190	2,011,280	3,604,034
Dyeing and Tanning Materials	35,295,800	45,614.580	33,843,167
Indigo	29,474,340	38,630,840	26,925,107
Myrabollams	1,581,880	3,176,140	3 531,701
Wheat	11,242,670	57,926,150	39,044,963 (In 1898-99.) 13,802,000
Hides and Skins	37,384,590	45,243,620	104,633,863
Raw Jute	43,700,320	86,398,610	80,716,465
Manures	399,776	2,458,891	6,128,719
Oil Seeds	47,814,650	106,312,470	101,096,894
Raw Silk	6,042,870	6,737,690	7,158,019
Spices	3,266,940	5,890,090	5,799,248
Teak Wood	2,819,880	7,634,084	9,121,050
Raw Wool	11,877,990	17,791,640	18,019,545
Gums and Resins	...	2,051,730	1,078,710
Raw Hemp	...	45,243,600	69,755,900
Horns	...	198,472	1,240,550
Fish Maws and Shark Fins	...	...	1,400,000

IMPORTS.

Article.	In 1879-80. Value in Rupees.	In 1889-90. Value in Rupees.	In 1899-1900. Value in Rupees.
Apparel	5,612,940	13,930,430	14.944,395
Arms and Ammunition	1,270,027	4.671,709	3,517,044
Chemicals	996,630	2,574,960	4,647,723
Manufactured Cotton	196,690,530	298,813,440	294,908,291
Drugs, Medicines, and Narcotics	4,369,550	5,348,770	8,694,711
Dyeing and Tanning Materials	1,618,330	5,154,870	6,433.592
Liquors	14,961,690	14,891,210	75,976,913
Oils	640,240	1,663,870	2,156.304
Silk Goods	8,378,900	17,781,140	11,298,310
Sugar	10,687,880	22,000,490	33.766,299
Woollen Goods	10,284,500	15,975,490	18,523,096
Manufactures of Wood	...	1,588,070	1,503,940
Gums and Resins	...	1,226,350	769,480
Manufactures of Leather	...	184,818	1,268,390
Paints and Colours	...	2,673,669	2,314,330
Porcelain and Earthenware	...	2,239,200	1,326,910
Glass	...	6,071,270	5,111 010
Watches	...	2,394,070	2,317,290

Then, again, some of the natural produce we export, may be exported in a partly manufactured form in order to keep the profits of labour at home. Instead of sending out coffee, coir, wheat, raw jute, oil seeds, spices (raw), horns, fish maws and shark fins in their natural condition, we may send respectively ground coffee, matting, flour, manufactured jute, oils, ground spices, gums, &c., which would probably give employment to a considerable portion of our people.

India, it must be admitted, has no capital. As the land is thirsting for water, industries are famishing for want of capital. It may be true that in very ancient times India used to export its surplus produce to all countries in Asia and some of Europe, and bring gold and silver in return. This may have led to a comparatively fair accumulation of capital, but since the time when foreign invasions began, the happy state of things was put out of order. The Mahomed of Ghizni, in his twelve expeditions, Timurlane, Nadirshah, and many of them, carried enormous wealth out of the country. And this was followed by a period of internal dissensions and constant warfare. Commercial activity seems to have stopped. Ignorance and fear of being robbed by the chiefs and of suffering physical injury, or even loss of life in addition, induced people to bury their treasures underground, which rendered it unproductive. People followed the example of the princes and chiefs in squandering money in unproductive luxuries and idle pursuits. Absence of modern greed bred indolence. Personal jealousies and rivalry in pomp and show prevailed. Even recently a dispute about a goat led to a fight between two princes, which resulted in sixty villages being desolated. Combined with this was the custom of early marriage, which increased the number of children dependent on stagnant incomes. The "Streedhan" institution was most useful and valuable to a defenceless widow in a social point of view; all these considerably helped to reduce the capital of the country to a vanishing stage. As India's manual work and human power must disappear by the advance of modern machinery and physical agency, so must her isolated skill before combined and distributed work. This makes not merely capital, but large accumulated capital, a national want of India. But there seems to be a feeling lurking in the minds of some, especially in India, to look upon foreign capital as a great evil to a country, as a thing to be despised and checked whenever possible. This feeling seems to have been founded on the belief that foreign capital employed in a country, takes away all the profits of industry out of the country, leaving only wages in the land. Now it must be remarked, that interest on the capital and profits on the capital are two different things; the one is natural and the other legal. If you put a bottle of wine in your cellar and open it after ten years, it increases in value with almost no labour: but if you give a man a pound of wool and ask him to weave a piece of cloth, the difference in the price of the wool and cloth is profit caused by, and, therefore, due to labour. Nature, therefore, allows interest to capital and profits to labour. What is allowed by Nature, no man has right to prevent. But when the nominal capital is more than what is actually applied to productive uses, when large sums are absorbed by managing "rings," when wages of administration and superintendence are unnecessarily high, and when there is an element of monopoly, profits are always mistaken for interest. A few years ago the exchange banks in India decided not to accept bills from Indian traders unless they were signed by some European broker. The money latter received for signature was not interest, neither profit on labour, but came out of the element of monopoly of exchange enjoyed by the banks. If we, therefore, properly discriminate profits thus derived from the legitimate returns of capital as an agent of production, there will be no objection whatever to the capital of any country going to another. As a matter of fact, no nation requires its own capital. Capital is international, and runs where it can obtain greatest interest. Therefore, if India wants capital, and the capitalists of the West a higher rate of interest, a proper understanding must be arrived at on the items of interest and profit, in order to remove the prejudice of the people of India, which prevents co-operation and thereby the full productiveness of the capital.

Another proposal which does not receive as much encouragement as the former is to start workshops and factories in India by British capital, whose interest may be guaranteed by the Government of India, a principle which has been already adopted by the Government in the construction of railways. As I have said before, the introduction of new and the revival of the old industries now being a matter of greater importance and urgency to the interests of the people, there is no reason why an experiment should not be tried in this direction. But a system of such kind, by being guarded against loss invariably leads to enormously expensive administration, thus absorbing a considerable amount of the taxes of the people.

Another idea has been suggested, namely, that India should adapt her articles to Western requirements, so that she may occupy a place in the markets of Europe and America. Though the idea aims at a small object, it suggests many points for our consideration. It is true that Japan's efforts in this direction have been greatly successful. One can see more Japanese articles in an English, French, German, or American home than one used to find twenty years ago. A similar success for India means a great encouragement to the revival of old Indian industries.

If the skill of embroideries on shawls and silks and of muslins had been utilised and adapted to adorn the magnificent dresses of the beauties of Europe and America, perhaps those industries would have held their breath a little longer. The carved woodwork, brassware, and ivory carving might have found a little more favour if they had been adapted to Western taste and pushed commercially in Europe and America.

But India has to labour under two great obstacles to the general advance of her commerce. Almost all important countries have their consuls or commercial representatives in India, to study the demands of Indians and introduce their manufactures amongst them. But India has no such distinct commercial agency which would watch the growing demands of different peoples, so as to direct the native skill in a profitable manner, and push her articles abroad from time to time. A few months ago we heard about a Japanese deputation sent to Russia to find out the best means to encourage Japanese articles in that vast Empire. Such steps are most essential for a rising country. Secondly, a corresponding agency at home, such as the commercial statistical bureau of Japan or the United States, which will watch the commercial activity at home and explore new ways and means for its encouragement, is also conspicuous by its absence. There are, no doubt, the chambers of commerce and institutions such as millowners' associations, but their activity is confined either to the trade of Presidency towns, or to an individual industry.

No doubt an efficient organisation of some sort seems to be a great necessity, both for industrial encouragement at home and advance of commerce abroad. The Government of India with its present means, may perhaps not be willing to undertake such a heavy and highly responsible work. Perhaps the Government of India may meet with opposition from various quarters, if it undertakes to divert part of its revenue or loans for the encouragement of new industries in the country, on the principle of the Dutch culture system or Indian railway policy. It will perhaps be saddling the Government of India with too much work, if we expect them to do what the Japanese Government did for Japan. Yet there seems to be no hope for the industrial development of India without foreign capital at low interest, and effective official superintendence. The position may be simplified by establishing an Imperial Industrial and Commercial Board, containing partly official and partly non-official members, who may be supported by provincial boards, constituted on similar lines, in presidency towns, and these in their turn may utilise the various district boards or separate corporate bodies in smaller towns. These boards may be empowered to borrow money from the Government at low interest, and make advances to people of good standing for the development of rural and urban industries; all the transactions of these boards being under the strict superintendence of the Government officials of the district and provinces. The Government may encourage these efforts by giving the benefit of the experience of the heads of various expert departments in actual co-operation with such bodies. The Imperial Board may also be authorised to appoint representatives in the leading markets of Europe and advance Indian commerce all over the world, to organise periodical industrial exhibitions, to bring about a closer inter-communication in the commercial relations of the East and the West. We may seek satisfaction by pointing out merely the direction of this step, leaving the details to be settled by the wisdom and convenience of the Government of India.

The deposits of Post-office savings banks, which attained a total of nearly 10 crores of rupees in 1899-1900, and which is dead capital yielding nothing to the country, may well be kept at the disposal of this industrial board to be utilised with the sanction of the Government on productive industrial works. Without attempting here to advance all the arguments which come naturally in support of this proposal, I will boldly claim that it will obviate the evils and inconveniences which have been seen to attend the working of the existing system, or rather the total absence of a system, in a department of national life which every other civilised nation exhibits in varying high degrees of efficiency. The inevitable and natural slowness on the part of the people of India to appreciate the efforts made on unfamiliar Western lines; the indolence which results from the lack of stimulating examples in their neighbourhood; the confusion and suspicion which are due to the want of an agency which would rightly interpret to the Eastern mind the meaning and scope of Western methods; all these evils and many others would, I maintain, give place to a healthy activity and natural productiveness.

We have yet to indicate the most important line of work for the people of India amongst themselves. No doubt we have had too much talk about industrial developments, and I think time is now ripe for action. We have up to now discussed schemes which necessitate the Government taking the initiative and leading the people in the cause of progress. The present condition of Indian society makes such a course necessary, however it may seem inexpedient to Western minds. Desire of self-interest and pursuit of private gain alone guide a Western individual. Capital and labour is free to move from one employment to another which promises better remuneration. With us it is quite different. The pursuit of self-interest is qualified by considerations of family and caste. Our occupations, our home, and our future are all chosen for us by our parents, and we have to move in these narrow grooves; custom prevails over competition, capital and labour can only run in fixed channels; and the State alone is acknowledged to be the leader. This may be the result of the unsettled and insecure political condition of the country previous to the benign influence of the British rule, the process of concentrating all national power in the State, or the influence of Hindu philosophies preaching that this miserable life is temporary, and that it is better to pursue the glory of the next world than of this.

Under such circumstances, the hope of the nation rests mostly on the educated classes of the community who have assimilated Western culture, and on whom lies the responsibility of guiding the whole nation. If then, what we have said at the beginning of our remarks be true, namely, that there is enough enthusiasm shown for industrial development in India, here may be pointed out a great field for practical work.

No doubt the producing capacity of a nation varies with its consuming ability which, in India, is very low; but this is due more to the necessity, caused by poverty, than incapability to increase and enjoy a higher standard of comfort. The present style of living deteriorates the physical constitution, and consequently cripples the power of the mind. It seems to me that India is suffering more from ignorance of the methods of co-operation and commerce, than from the occasional natural droughts. It seems that disunited India is falling a victim to the combined trade of Europe. If only people could co-operate with each other honestly and earnestly, the auspicious day when we may see the rising of the sun of regeneration of India will be near at hand. We may differ in politics, in religion, in various things, but there can possibly be no hindrance in our way for uniting, at least, for trade purposes. Perhaps the masses of the people may not yet be able to grasp the real usefulness and strength of this principle of co-operation. The responsibility, therefore, on the educated classes is greater. They have to take upon themselves to enlighten the spheres in which they move, and induce the people by gentle and persuasive means to co-operative action. The needs, or speaking commercially, the custom of 300,000,000 of people is not a thing to be omitted from our consideration. It is a source of power which has been hitherto utilised in developing industries in foreign countries and feeding two or three intermediaries between the producers and consumers. If properly regulated and controlled it might unfold to us the shortest way for the development of the resources of India, both material and moral. The greatest hindrance to a new industry has been the doubtful sale of its products, and if but the sale of products is guaranteed very little more may be wanting. A great commercial movement on the co-operative system is, therefore, highly needed. Cities, towns, villages, may all be joined together by a sort of network of such movement. And when the demand of the people is once taken under control small industries may be started by the accumulation of small capital belonging to the Indians themselves, and good understanding may be arrived at with foreign capitalists, who would be only too willing to start a concern the sale of whose products will be partially guaranteed. The shortest and best way to accumulate capital in a country no doubt is to induce foreign capitalists to come and settle in the country, but the tropical climate and evils attending it, prevent such a desirable end in the case of India. In the absence of this we may rely on the beneficent help and guidance of the shining luminaries who predominate in the Indo-European trade. No doubt such an effort demands rigorous honesty and ceaseless energy which the educated classes of India should be able to supply. The operations of this movement, instead of keeping confined to the manufactures alone, may gradually be extended to the agricultural and other operations in bringing them into closer touch with the commercial race of the world. Impediments to co-operative movements generally originate from the richer classes, as it limits the field of their surplus wealth. It is for this reason that the movement does not make such rapid progress in this country and much less in America, in proportion to the intellectual capacity of the people. But in a poor country like India, the benefits of this system would be quickly and easily appreciated, and we may hope for phenomenal success to a well-directed, conscientious and earnest attempt. All the different races and nationalities will be brought together, and their commercial friendliness may also lead to national unity.

This will also avoid another great evil against which I may, in conclusion, utter a note of warning. If India is to strive for progress, she must strive for a sound and uniform progress. A few days ago, the Right Hon. Lord George Hamilton, in comparing the poverty of India to that of the City of London, remarked :—

> "In the last twenty years London has made most extraordinary strides in the wealth, and attainments, and habits of its population, in income, in rateable value, or, tested by any gauge economic science can suggest, there had been great strides in material advance. And yet it is but a few years back that those interested in social subjects were startled by the statements in Mr. Charles Booth's book, in which he analysed the condition of the people of London classifying them according to their incomes, their wealth and poverty, including those who were in receipt of Poor Law relief, those who were in chronic want, and those who from time to time had difficulties in obtaining the necessities of civilised life. The result of his investigations, minute and elaborate, was that he estimated not less than 30 per cent. of the population of this great city were in a condition equivalent to pauperism."

This, no doubt, is a very keen and statesmanlike observation." At the same time it must be said that his Lordship only touched the fringe of the great problem that must engross the attention of all civilised nations of the world. The above description is true, not only of London, but also of other great cities of Europe and America, where wealth, civilisation, enterprise and material progress have made the greatest advance. Says Henry George:—"In the United States it is clear that squalor and misery, and the vices and crimes that spring from them, everywhere increase as the village grows to the city, and the march of development brings the advantages of the improved methods of production and exchange." In fact, it is painfully amazing to notice the deepest poverty, the sharpest struggles for existence and the most enforced idleness in the midst of the densest population and ever-increasing wealth and progressing civilisation. How is it that in London, where every agency for the development of the material resources of the people are in full work, and where philanthropy, benevolence, and every form of public charity are doing so much to alleviate unavoidable distress, how is it that here one-third of the people are existing only one stage above starvation? It seems that while the wealthy become wealthier, the poor become poorer. The wealth and progress of a nation is judged by the activity and the display of the few, and not by the increasing struggle for existence of the many. In the words of the Bible:—"To him that hath, much shall be given, and from him that hath not, the little that he hath shall be taken away."

The consideration of this problem is pertinent to our present inquiry. For industrial development is not an end in itself, but a means of bringing about national good. The problem, however, is beyond my grasp. But this I will say, our aim should be, not to justify the general and chronic poverty of India by the abnormal disparity in the condition of the rich and poor of this country, but to do our best to save India from being inoculated with the germs of this disease, which is characteristic of the so-called "modern progress."

DISCUSSION.

The CHAIRMAN said the paper was directed towards the object of seeing how India could learn to produce for herself what she now imported. He thought everybody was agreed that no stone should be left unturned to enable India to produce, as far as possible, what she now imported. But the primary consideration of the matter must not be forgotten, that India had for centuries past been an agricultural country, and he did not see how the government of any country could suddenly change all that had gone before, merely by a desire to do so. While all were agreed on the main point, they disagreed when they came to consider how the object in view was to be attained. Technical education was supposed to be the panacea for all evils. It was thought that by a widely extended system of technical education, India's agricultural difficulties would disappear, famines and plague no longer recur, and India become one of the largest manufacturing countries in the world. He sincerely hoped that this might prove to be the case, and he said, with every confidence and with the authority the position he held in the Indian Office gave him, that it was the intention of the Government of India and of the Secretary of State to spend what they considered a fair proportion of the revenue of India on technical education in the very near future. The Viceroy had stated in very concise terms, that at the present moment there were two forms of technical education in India—one in the colleges or schools, and that given in industrial schools. Continuing, the Viceroy said that the two systems must be turned into practical plans, so that a boy might not merely pick up a smattering of an art or an industry for which he had no care, but acquire a training for a professional career. The natives must be invited to co-operate in the matter; for it was no use creating good schools if the pupils will not come into them, or manufacturing good workmen if no employment is available for them when they have been taught. If they proceeded on those lines, the Viceroy believed that something substantial would be done for the cause of technical education in the country. He had referred to this speech of the Viceroy's, not in any way as an answer to Mr. Waglé's remarks with reference to technical education, because he had noticed, with pleasure, that throughout the paper, its author recognised, in a very broad-minded manner, the difficulties in the way of carrying out some of his own suggestions. One matter which had a great bearing on the subject of the paper had not been referred to, namely, the political and military considerations of India. It was impossible to deal with the industrial development of India, without taking account of those important considerations. It was obvious, that as long as large sums of money had to be spent on maintaining the necessary army in India in an efficient state, it was impossible for the Government of India to incur large expenditure in other directions. The author suggested that the construction of railways was a minor consideration; he could only say from his (the Chairman's) very inadequate acquaintance with the subject, that nothing had contributed so greatly to the present prosperity of India as the far-seeing policy of railway development initiated and carried out by the Government of India. Anyone who had read and studied the Famine Report must, he was sure, come to the conclusion that had it not been for the increase of mileage of railways throughout the Empire, the suffering would have been a great deal heavier and more terrible than it was. In discussing such questions as the protection of young industries, State workshops, municipal trading, State loans for pioneer enterprises or subsidies, he ventured to think they were touching on very dangerous ground. He did not know why an English administration should proceed on lines of policy in India which had been from time immemorial fought against in the Mother Country and the Colonies. He did not say there might not be advantages in the State adapting some such measures, but it must be done very warily. In his opinion the matter was not ripe for consideration, because he did not see how the finances of India were going to bear the burden. He did not think the author had sufficiently recognised the advancing prosperity of India. During the last 50 years it would be found that, after allowing 4 per cent. on all unproductive capital invested in uncompleted railways, and counting the 2,000 miles of line which were added in 1900, there was a surplus of revenue over expenditure. That to him seemed a marvellous achievement on the part of the Government. It showed with what determination the policy of the Indian Government had been adhered to, and it was a source of the greatest encouragement for the future. The author had referred to the ill-fated arts of India. He was inclined to think there was not a country in the world at the present moment which had not its ill-fated arts. Day by day, in this country, they saw hand work giving place to machinery; and the fact that the arts of India had declined was not due to any fault of the Government, but to the simple fact that there were fewer buyers of such articles. Every country suffered from the same misfortune. In conclusion, he expressed the hope that the discussion of and consideration given to these questions would not prevent the public at home from continuing to feel the same pride and confidence in our system of Government of our great Indian empire.

Mr. F. H. SKRINE said that few papers more appropriate than Mr. Waglé's had been read before their ancient Society. It existed in order to foster the useful arts, and no country in the world needed them more than the Indian Empire. In the growing independence of the population on the overtasked soil, the Viceroy and his Councillors had a problem as grave as ever confronted a body of administrators. To this cause was mainly due the constant recurrence of famines; and unless it be dealt with in a statesmanlike spirit, the evil would soon be past remedy. Mr. Waglé had sketched the various methods adopted by European Governments in the East to guide the course of industry. The example of the Dutch in Java, was not likely to be followed, for it produced the very evil of over-population which lay at the root of India's calamities. The Javanese formed one vast peasant proletariat, and the system of forced labour reduced them to a condition of slavery, and led to ruthless exploitation by their foreign masters. In India, our Government had proceeded with halting steps. The advent of British capital was long hampered by red tape and the old jealousy felt by officials for "interlopers." Where it had succeeded in securing fair play the higher agency was mostly European, and the profits were drawn away from India to enrich the United Kingdom. In Japan the question of promoting industries had been solved satisfactorily. Technical schools and colleges had been established throughout the Empire, and the more promising students were sent to Europe and America at State expense to learn their crafts at the fountain head. Time after time during the speaker's voyages to India he had met batches of bright young fellows saturated with the latest knowledge, and eager to impart what they had learnt to their countrymen. Now there was no reason whatever why the Indian Government should not follow our new ally's lead. The native character is well adapted to the factory system, and the deftness of touch, the instinctive knowledge of art which had produced such marvels in the past still lingered in the people. And yet what had been done to restore the decaying industries of India, and launch her people on new careers? Almost nothing. When, about twelve years ago, the speaker found himself at the head of a great Bengal district, where arts unconnected with a very primitive system of agriculture were unknown, he founded a technical school under the local board, and sent copies of the rules formed for its management to similar bodies throughout the province. The experiment was a success. Young men belonging to the priestly, the writer and the lower castes laboured with zeal in the smithy and carpenters' shop, and the products of their industry were most creditable. He received every encouragement from Sir Steuart Bayley; but the best Lieutenant-Governors were not immortal, and on Sir Steuart's departure the Rangpur Technical School received no support from an Education Department wedded to the fetish of literary training. If the example of Japan were followed the young artificers fresh from Lancashire or Glasgow works would, even under present conditions, find abundant scope for their energies. The question of aiding the new industries thus started with capital, was a large one. The speaker knew the power of red-tape too well to accept Mr. Waglé's suggestion that the district boards under Government control should advance the funds for establishing factories. The result would be a plentiful crop of failures, and lasting discredit on the movement. Far better were it to make India's wants known at the centres of British enterprise. The speaker longed to see an intelligence department at the India Office, in close touch with the City, occupied in answering references, and acting as an intermediary between capital and the spheres where it might be usefully employed. By this means we should succeed in directing public attention at home to the limitless field offered by the latest resources in labour and raw material of the Indian Empire.

Sir LEPEL GRIFFIN, K.C.S.I., wished to say a few words in support of Mr. Waglé's arguments, which had been presented with much greater moderation and good sense than characterised the utterances of many of those who to-day were calling attention to the grievances of India, and he looked forward to the time when Mr. Waglé would take a high place among those who were working for the best interests of his country. With regard to the predominance of agricultural work in India, although superficially different, the condition of India to-day was very much like that of the great Empire of Russia. While the Chairman with great force, and, he had no doubt, rightly, spoke of the great difficulty of the change from the agricultural to the industrial state, he would like to point out that the Finance Minister of Russia, M. de Witte, had shown his wisdom by realising that the future regeneration of Russia was dependent to a great extent on her changing from her agricultural state of poverty, and very often famine, to an industrial state in which a very large part of the population would be relieved from the fear of famine and from disasters due to climatic causes. In every part of the world in which Russian policy sometimes appeared to be opposed to their own it would be found partly due to the necessity of Russia changing her hopeless agricultural position into a strongly founded industrial one. In that way there was a great deal of resemblance between India and Russia. He agreed with everything said both by the author and the Chairman respecting the enormous need for every effort being made to start India forward on an industrial career. He was exceedingly pleased to hear Lord Hardwicke say that the Indian Government was prepared to give a large part of the future surplus of the country to that great and most important work. India must be developed by English capital, and Mr. Waglé was sensible enough to see what some Indian critics could not see, namely, that English capital in India was a good and not an evil thing. Without it nothing could be done. There was no reason why English financiers and capitalists, who with their money had bolstered up every rotten State in the New World, should not provide many millions for the industrial regeneration of India, an investment that would amply repay them. The question of Protection was a difficult, and perhaps dangerous one, but he invited the Government represented by the Chairman to consider that the questions of Free Trade and Protection, which differed in every part of the world to which they desired to apply them, must in India be discussed with instant and direct regard to the interest of India itself. Free Trade and Protection must not be looked on with English or Manchester eyes, but simply for the good of India alone. The first article he wrote in "The Fortnightly Review," more than thirty years ago, was on that question, and he then urged the great desirability of imposing duties in India—he would not call them protective duties, but duties to encourage Indian arts and manufactures, and for revenue purposes and to raise the dead-weight of taxation from the land. For those purposes he thought protective duties might very justly and beneficially be imposed on India. But the question should be decided not on English grounds or by English people in England, but by the Government in Calcutta in the interests of India alone.

Lord Hardwicke being obliged to leave to fulfil an engagement in the House of Lords, the chair was taken by Mr. W. S. SETON-KARR.

Professor WYNDHAM R. DUNSTAN, F.R.S., said the author had rightly recognised the importance of higher scientific education and industrial enterprise going hand in hand. Mr. Waglé had referred to him as having recently in that room supported Mr. Tata's scheme for the establishment of a research institute in some central place in India. What he had, however, suggested was the establishment in India of a school of mines and metallurgy. Such an institution, he believed, would be of very considerable value. If he understood Mr. Tata's scheme aright, it seemed to him to be altogether premature. He was inclined to think, that what was urgently needed was an extension of facilities for the higher teaching and research in the existing universities and colleges throughout India. Funds should first be provided by Government for this purpose. It appeared to him that a research institute, where post-graduate students were to make researches with the object of starting industrial enterprises themselves, would not succeed at present on account of their being practically no properly qualified workers. One must remember, too, that the starting of industries was not merely a scientific question; it was an economic problem of some complexity. He was heartily in sympathy with Mr. Skrine's suggestion that there should be in connection with the India Office a commercial intelligence department, which would enable English people to know more about the economic resources of the Indian Empire, so that British capital might be directed to India, and in that way new industries started. Several important industrial developments were now taking place in India which had been accomplished entirely upon these lines. The author had rather discouraged the idea that much good would result from Sir Mancherjee Bhownaggree's suggestion of technical schools throughout India. No doubt they would produce a slow effect, but it was well known that technical education, especially in handicrafts, was not to be neglected, and he ventured to think the decay in the national industries was very largely due to the want of a demand in other European countries for those particular articles. What was required, was the encouragement of sound native industries, which could be very largely effected through the establishment of technical schools of handicraft.

Sir GUILFORD MOLESWORTH, K.C.I.E., said that sixteen years ago he wrote an article in "The

Calcutta Review" which, in some respects, went a good deal further than the suggestions of Sir Lepel Griffin. In that article he had pointed out that India has untold wealth, wonderful natural resources, whether agricultural, mineral or industrial, but they are to a great extent dormant. It has coal of an excellent quality; it has fine petroleum, large quantities of timber and charcoal; it has iron of a purity that would make an English iron-master's mouth water, spread wholesale over the country, in most places to be had by light quarrying over the surface; it has chrome iron capable of making the finest Damascus blades, manganiferous ore, splendid hematites in profusion, it has gold, silver, antimony, tin, copper, plumbago, lime, kaoline, gypsum, precious stones, asbestos, soft wheat equal to the finest Australian, hard wheat equal to the finest Kabanka, it has food grains of every description, oil-seeds, tobacco, tea, coffee, cocoa, sugar, spices, lac, dyes, cotton, jute, hemp, flax, coir, fibres of every description, in fact, products too numerous to mention. Its inhabitants are frugal, industrious, and capable of great physical exertion, docile, easily taught, skilful in any work requiring delicate manipulation. Labour is absurdly cheap, and the soil for most part wonderfully productive and capable of producing crop after crop without any symptoms of exhaustion. England in her dealings with India has committed the same blunders as she has committed in her dealings with Ireland. She has never sufficiently protected the industries of Ireland from English manufactures. But during the last 40 years she has allowed her to be swamped by the flood of unlimited foreign competition, and has since fruitlessly endeavoured, by frantic land legislation, which has made matters worse, to patch up the results caused by this blundering policy. It is precisely the same with India, she has persistently drained her resources, swamping her with English and foreign productions, and instead of fostering her industries has handicapped them in every way. Everywhere in India may be seen evidence of iron manufacture crushed out by unlimited foreign competition; throughout the whole country may be found old slag heaps, testifying to the former prosperity of native iron industries, the splendid native iron being now superseded by cheap worthless iron of foreign manufacture. Many attempts have been made to revive and start afresh iron industries, but they have one and all been crushed out for want of a little fostering protection. The latest attempt nearly succeeded, but the modest request for a little help was sternly refused, and the company broke down. Throughout Bengal one may see the ruins of the English Indigo factories. Coffee and tea are struggling hard for existence, planters are ruined, and their estates bought at depreciated rates in times of depression. This enables the industries to survive with some show of prosperity in good times. Coal is doing fairly, but not nearly so well as it should do if our manufacturing industries were fostered. Cotton manufacture has sprung up under a protective tariff and appeared to be prospering, but selfish Manchester called for its sacrifice, the tariff was removed, and the industry left to perish or struggle on as it could. Several capitalists who embarked in the cotton manfacture on the faith of this tariff have lost their money. Manufactures and industries would never be introduced into India until they were protected. What had happened in America? Ruin had always been predicted as the result of the McKinley tariff, but what had happened? A tariff had been placed on tin plates, in order to induce the manufacture of tin plate in America. It failed. The tariff was then doubled, with the perfect success of the undertaking. Tin plate manufacturers sprang up in all directions, and the English industry have suffered terribly. The Americans killed the English monopoly, and enabled a most flourishing industry to arise. The price of tin plates in the United States fell from 5¼ to 4 dollars per box. Exactly the same happened in regard to the iron and steel industry. America was unable to progress with those industries until she put a tax upon them, and after establishing the industries, from being very much inferior to England in the production of iron and steel, she now surpassed her, producing more than England did herself. The British manufacturer said the duty and the price in the United States was considerably reduced. Industries would never be introduced into India until they were protected, not only from foreign countries, but from ourselves.

Mr. HORACE BELL, M.Inst.C.E., thought the subject of technical education had been mixed up with industrial development. As far as his experience went technical education in India had not been a success, and he very much doubted whether it ever would be in the way in which it was now carried on. There was no better workman to be found than the Indian; he was very clever, hard-working, and in every way a satisfactory person to deal with. It was important to remember that men should not be taught to run factories before the factories were there, and the factories would not be obtained in India until the capital was forthcoming. One great advantage possessed by India which had not been referred to by the author was, that the Indian workman was just as good at a shilling a day in attending to a machine as the British workman at five shillings a day. That was the important secret of success in starting factories in India in competition with England.

Mr. ALEXANDER ROGERS thought industries would be promoted in India if the natives of the country came over to England and learned them personally. The author himself had adopted that plan. He had learned glass-making practically, and hoped to go back to India and introduce that industry. A great many industries, which the natives themselves could carry out, would require very little capital indeed. Even in agriculture, many of the resources of the country were now thrown away, such as manure which might be utilised to very great effect. In the last famine, millions of cattle died, but their skins had gone abroad and helped to benefit the Italians and other people. If the bones of these cattle had been ground up in India, it could have been done at small expense with native capital, and it would have redounded to the benefit of agriculture. Why should not the vast number of horns and hoofs be turned to account? There was abundance of tussore silk in the jungles of the Bombay Presidency, and if the industry of reeling that silk had been introduced he believed there would have been no famine at all recently in some parts of the country.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Waglé for his paper.

Mr. WAGLÉ, in reply, thanked the audience for the kind and patient hearing given to him, and for the hearty way in which they appreciated the views he had ventured to submit for their consideration on the important subject of the industrial development of India. He was quite satisfied with the discussion, and remarked that although the differences of opinion were few, still most of them would not have arisen, if he had only time to read the paper in its entirety.

Sir WILLIAM WEDDERBURN, in proposing a vote of thanks to the Earl of Hardwicke and Mr. Seton-Karr, for occupying the chair, said the Society was greatly indebted to his Lordship for being present, and showing the official interest he had taken in the very important subject under discussion. He (Sir W. Wedderburn), was glad to hear Lord Hardwicke's encouraging words, and the promise he had given of support to the objects which the author had in view. It appeared to him that the people of the country had a very strong claim upon the people of England, and upon the Government. Much had been heard of the sad way in which their ancient arts and industries had been extinguished, owing to the force of circumstances, by free trade and machinery, and that placed an additional responsibility on the English people to help the cause advocated by Mr. Waglé.

The proceedings then terminated.

The time at my disposal at the end of the discussion on Mr. Waglé's paper was so short that I was unable to say much that I had desired to. Several of the speakers apparently seemed to consider the idea of promoting local industries was hopeless without the assistance of English capital, but this conclusion seems to be come to on insufficient grounds. There is already in existence in India, and especially in Bombay, a large cotton, silk, and jute industry, which is but very partially due to the expenditure of any but native capital, and there are many local industries that could be started with the latter. I casually mentioned the bone industry, and a native gentleman in the audience remarked that bones were exported as well as hides. Why should this be? Machinery for the grinding up of bones is not of an expensive character, and the phosphates contained in them could be made into valuable manures for the land, which would yield larger returns for its use. Then, in addition to the manufacture of glass, now carried out in a very primitive and unscientific method at Kapadvanj in the Kaira Collectorate, and which it is hoped that the knowledge acquired by Mr. Waglé's own practise in England will soon help to rectify, there are other industries to which the attention of native capitalists might be profitably directed. Take, for instance, that of Tasar silk, the worm* that produces which is abundant in the jungles of Gujarat, and which is already firmly established in Bengal. It lies at the very doors of the owners of the cotton factories in Surat, Broach, and Ahmadabad, and yet has never been thought of. I can assert from personal knowledge that if the reeling of this silk from the wild cocoons had been introduced among the Bhíl and other women there, there would have been no famine in the Punch Mahals in 1899-1900, for they could have earned wages wherewith to buy food, which local traders had amply provided on the spot. Again, there are large deposits of iron, hæmatite, magnetite, micaceous iron, &c., of as fine quality as any in the world, lying utterly useless within a few miles of the station of Bodeli, the present terminus of the Gaikvar's Dabhoi line. The remains of slag in many parts of that region prove that in former days, when there was plenty of wood for smelting it procurable, there must have been an extensive iron and steel industry. This has died out in consequence of the importation of cheap European iron, and from the absence of coal in the country this industry could not be revived without large capital for the introduction of electrical appliances, to be worked possibly by water power to be derived from the Nerbudda and Mahi rivers. It is, however, worth the consideration of European capitalists, as well as the curing of hides on the spot instead of exporting the raw material to the Continent, as was done on an enormous scale during the late famine, and other local industries that would supply the great desideratum for India of providing means for the earning of wages in addition to the present overburdened calling of agriculture.

A. ROGERS.

Mr. Waglé's paper was most instructive, but like all lecturers on the subject, of whom I have any knowledge, he did not allude to the vast practical, technical, educational work carried on by the railways of India. The hundreds of thousands of natives that are at present, or have been, employed on railways, have all been made useful citizens, more or less; in the locomotive, traffic, and engineering departments, they have of necessity picked up highly technical knowledge. The common coolie rises from cutting earth, to being a platelayer, keyman, ganger, or even foreman or mistri; the cleaner, if of ordinary intelligence, becomes a fireman, then driver, or if employed in the vast locomotive shop, can attain to the highest ranks; and the station porter has opportunities of learning signalling, both manual, telegraphic, and mechanical, or, if his talents take another bent, of serving through all the ranks, from goods guard or clerk to district superintendence; and, moreover, throughout their career, they are in constant touch with their English superiors, and get promotion by the exercise of those very talents that have made Britishers what they are—reliability, energy, common sense, presence of mind, and courage in an emergency. These talents are not usual amongst the natives of India, for want of that very cultivation which they get on railway work.

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* The *Antherea mylitta*

ERNEST BENEDICT.

Two topics were mentioned in Mr. Waglé's paper which failed to secure direct attention in the course of the discussion that followed—one pertaining to the subject-matter, and the other being one of the methods suggested in aid of Indian industries generally. Mr. Nilkanth Waglé enumerated several of the decorative arts, from Cashmere shawls to silver ware and jewellery, and quoting an Indian friend of his, who expressed a hopeless view as to this branch of the subject, to the effect that these once-famed hereditary arts are gone —lost by Indian handicraftsmen for ever. But we must not accept this conclusion. The present position of these artistic industries is bad enough, and, mostly so, in the deterioration, which, in the struggle of the artizans to keep their place in the community, has lowered the style and distinctive qualities of such wares—textiles, metal-work, gold or silver ware, sandal wood and ivory-carving, and the rest; and yet whilst the few discriminating observers who keenly appreciate the peculiarly special qualities and traditional designs shown in these handicraft productions, appeal to us, ever and anon, to rescue them from oblivion, and to encourage the wearied, surviving artisans to keep on, we should not despair. As one who has traced this difficult problem into its elements, I cannot admit that it is even now a forlorn hope. As compared with the mechanical industries and manufactures of commercial value, dealt with so well in this paper, the decorative handicrafts of India cannot compete for public favour or support. No machinery can assist them; no motive power can increase the output of this essentially unique branch of production. Indeed, if they are to survive, these modern appliances must be kept far from them.

Where, then, shall come help for these vanishing arts? One method suggested in the paper, but for quite other purposes, and on a larger scale than is needed for our object, was that of subsidies—either from the central treasury or provincial funds. We know that as regards the larger industries and commercial development this method is beset with difficulties behind and before. But on behalf of these inestimable handicraft arts the case is quite otherwise—and it is the only way. The total amount needed, whether from central or local sources, would be a mere trifle compared with the cost of experimental, technical, and other scientific efforts, to which, under the fresh impetus given by the present Viceroy, the Indian Government is already committed. There is one secondary consideration which makes the application of this method of rescuing Indian decorative art more feasible, namely, that these industries are mainly local in their habitat, and within small compass, as regards each of their interesting varieties. Many, if not most of the more valuable survive within the territories of the Indian States, the chief and ministers of which would often be very willing to provide the moderate subsidies required if the way were shown how to administer fresh nourishment to those indigenous hereditary handicrafts. For the rest, the more energetic and hopeful amongst the provincial administrators and district officers could be depended on to promote this much needed revival. There is one general principle on which this beneficent movement can be amply justified, that is in a motto deftly formulated by Goethe, namely, "We should encourage the Beautiful, the Useful will encourage itself."

W. MARTIN WOOD.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 12th, 1902; A. D. HALL, Principal of the South-Eastern Agricultural College, in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, Robert Hay, Assoc. M. Inst. C. E., M.Am.Inst.M.E., 1a, Independencia Num. 9 (Apartado Postal 866), Mexico City, Mexico.
Bennett-Goldney, Francis, F.S.A., Abbot's Barton, Canterbury.
Crouch, Archer Philip, 106, Cannon-street, E.C., and 24, Micheldever-road, Lee, S.E.
Gray, Charles, 4, West Regent-street, Glasgow, and Rossarden, Kilmalcolm, Renfrewshire, N.B.
Kennedy, John, 11, Fellows-road, N.W.
Kitson, Arthur, The Kitson Lighting Company of Great Britain, Limited, Blackfriars, E.C.
Lanza, Professor Gaetano, 22, West Cedar-street, Boston, U.S.A.
McBryde, Professor John McLaren, Ph.D., LL.D., Virginia Polytechnic Institute, Blacksburg, Virginia, U.S.A.

Miller, Frank S., Manor House, Old Malden, Worcester-park, Surrey.
Payne, Hon. George, J.P., M.L.A., Durban, Natal, South Africa.
Rollo, James Theodore, Superintending Engineer, P.W. Department, Maymo, Burma.
Tomlinson, Frederick John, Riverdale, Manor-road, Teddington.
Wall, Charles, Ashburnham Works, Lots-road, Chelsea, S.W.
Walser, Conrad, 28 and 29, Cheapside, E.C.

The following members were balloted for, and duly elected members of the Society:—

Cardona, Joseph, jun., 1, Church-street, Gibraltar.
Cook, James B., Ph.D., Randolph-building, Memphis, Tennessee, U.S.A.
Cowie, Archibald, Messrs. Cowie Bros. and Co., Glasgow.
Dale, Charles Ernest, care of Sir Charles R. M'Grigor, Bart., and Co., 25, Charles-street, St. James's-square, S.W., and Southern Nigeria, West Africa.
Frames, Minett Edward, F.G.S., P.O. Box 3517, Johannesburg, Transvaal Colony, South Africa.
Gah, Moung Oo, Yedashe, Burma.
Gates, Elmer, Chevy Chase Circle, Washington, D.C., U.S.A.
Harris, Lloyd Price, M.I.Mech.E., 32, St. Leonard's-avenue, Bedford.
Holmes, Charles R., 28, Sutton-court-road, Chiswick.
Jenney, William Le Baron, 520, New York Life Building, 171, La Salle-street, Chicago, U.S.A.
Knoblauch, Louis, 22, Baltic-street, Leith, Scotland.
Macfarlane, Walter, 22, Park-circus, Glasgow.
Rea, Samuel, Bryn Mawr, Montgomery County, Pennsylvania, U.S.A.

The paper read was—

THE UTILITY OF ALKALINE PHOSPHATIC MANURES.

By John Hughes, F.I.C.

Before considering the subject included under the title of this paper, it will be desirable to briefly refer to the origin and progressive use of

Acid Phosphatic Manures.

The manufacture of superphosphate in this country may be said to have commenced in 1842, when the late Sir John Bennett Lawes, F.R.S., obtained a patent for treating finely-ground mineral phosphates, such as Cambridge coprolites, with commercial sulphuric acid. The chemical theory then put forth maintained that the agricultural value of phosphatic manures depended upon the extent to which the phosphates they contained were rendered soluble in water through the aid of acid. It was contended that this solubility in water effected the most complete diffusion through the soil that could possibly be obtained, and the theory in itself is still correct, though its application should be restricted to soils containing plenty of lime, so that the acidity of the manure may be immediately absorbed by the alkali in the soil. Indeed, at first, sulphuric acid being expensive, it was only used in small proportion, and great caution was observed in the mixing arrangements. Only a portion of the phosphates in the coprolites was rendered soluble in water, amounting perhaps to 20 per cent. in the manure produced, and frequently as much as 8 to 10 per cent. was left in the form of insoluble or undissolved phosphate of lime. Consequently, in those days, superphosphate was sent out in an excellent dry condition, and this in itself contributed very materially to increase the sale and render the new manure popular among farmers, for there were never any complaints about the damp acid condition of the manure.

When acid, however, became cheaper as the result of improved manufacture from less costly materials, and as competition increased on the expiration of the original patent rights, sulphuric acid was added in greater quantity, and the utmost possible amount of soluble phosphate was obtained, so that only 2 or 3 per cent. of phosphate of lime was left in a condition insoluble in water.

Superphosphate then became damper and more acid, so that complaints respecting its bad condition were of frequent occurrence.

Superphosphate when first introduced was chiefly applied as a manure for turnips and swedes raised on good arable land containing sufficient lime, yet there appears to have been some doubt raised in the mind of so keen an observer and experimentalist as the late Dr. Augustus Voelcker, F.R.S., as to whether acid manures were not conducive to disease in these roots.

At any rate, as early as 1863 we find him writing in the "Journal of the Royal Agricultural Society" upon "Phosphatic Manures for Root Crops" as follows:—

> "Superphosphate of lime applied to root crops has a different practical effect on different soils.
>
> "Purely mineral superphosphates fail to produce good turnip crops on light sandy soils.
>
> "It has indeed been observed that the exclusive use of superphosphate, however beneficial it may be in the majority of instances, has in some soils led to the complete or partial failure or the presence of disease in the turnip crop.

"No acid combination as such can enter into plants without doing them serious damage; even free vegetable acids, as humic and ulmic acids, are injurious to all crops cultivated for food for the use of man or beast; and unless these acids, which are always present in what practical men call sour humus, are neutralised by lime, or marl, or earth, none but the roughest and most innutritious herbage can be grown.

"Free mineral acids, are, I believe, still more injurious to all farm crops, and perhaps to all plants, than the free organic acids that are found in humus.

"A very dilute solution of sulphuric acid,—say one part in 1,000 of water,—may be used with advantage for killing grass in gravel walks made with flint or quartz sand; after one or two applications, the weeds will be destroyed and will not reappear for a long time. But if the walks are made with limestone gravel, the application of a much stronger acid has little or no effect on the grass or weeds; after some time the latter seem to grow all the better for having had a taste of dilute sulphuric acid. In reality, however, no acid enters these plants, but on coming into contact with the limestone gravel, unites with the lime to form that useful fertilizer, sulphate of lime or gypsum.

"These examples thus prove unmistakeably that a soil which contains free acid, in ever so small a quantity, is unfit to maintain a healthy growth.

"We have, therefore, strong presumptive evidence that soluble phosphate, a combination which has a strongly acid character, does not as such enter the roots of plants.

"The reconversion of soluble into insoluble phosphate, perhaps may appear undesirable, but in reality, it is not only beneficial, but absolutely necessary to the healthy and luxuriant development both of turnips and all other crops to which superphosphate is applied.

"The more rapidly and completely the soluble phosphate in commercial superphosphates and turnip manures, is precipitated and rendered insoluble in the soil, the more energetic will be its effect upon the turnip crop."

The above statements, made nearly 40 years ago, represent the views of one who was rightly regarded as an authority upon the properties and use of artificial manures, and it is interesting to note the extent to which these views have been realised in actual farm practice during succeeding years.

NEUTRAL PHOSPHATES.

In 1875, the Aberdeenshire experiments with finely-ground phosphates were instituted and conducted under the management of Professor Jamieson for some years. The publication of the results excited much interest, for they demonstrated by actual field experiments that insoluble, or more properly termed undissolved, phosphates, if applied in a finely-ground condition and in sufficient quantity, possessed very considerable fertilising value, whereas, according to the previously held theory, such raw phosphates were supposed to possess no practical manurial value.

Further, these experiments proved that on certain soils, deficient in lime, ordinary soluble phosphate was not superior in its action as a manure to undissolved phosphates to anything like the extent that had hitherto been generally supposed.

Very naturally these novel results, being opposed to the theory hitherto held, excited a considerable amount of hostile criticism, which, however, time and more extended experience has proved to have been unreasonable and erroneous.

The experiments were carried out at five stations situated in different parts of the county of Aberdeen, and the soils are described in the official report as being "black mould resting upon a granite subsoil," and the analyses show that in every case they were specially deficient in lime. The figures for lime at these five stations were respectively ·08—·17—·21—·33 and ·38 per 100 parts of the dry soil.

These soils were in fact exactly those upon which soluble phosphate as supplied by superphosphate would not be likely to exert its full benefit, while the vegetable acids existing in the black mould would naturally dissolve the finely ground mineral phosphate to a very considerable extent. In short, the conditions were most favourable to the action of undissolved phosphates, and most unfavourable to the action of dissolved or soluble phosphates.

The experiments in themselves, were, however, distinctly useful both scientifically and practically, and Professor Jamieson will always be favourably associated with what must now be regarded as a step forward in the economical application of finely ground neutral phosphates.

ALKALINE PHOSPHATE OR BASIC SLAG.

About the year 1883 the now well-known basic slag or Thomas phosphate powder was introduced to the agricultural world. It is the residual slag resulting from the treatment of iron ore by the Thomas-Gilchrist process of adding lime in order to remove the phosphoric acid and silica. Briefly it consists of basic phosphate of lime and basic silicate of lime, associated with some iron, manganese and magnesia compounds.

It has a distinctly alkaline character, but it is a mistake to suppose that this material contains any considerable quantity of free lime, because any such excess of lime would indicate a wasteful method of manufacture, lime being only added in sufficient quantity to remove the phosphorus and silica existing in the original iron ore.

Though but slightly soluble in ordinary water, it dissolves to a certain extent in water impregnated with vegetable acids, and it is the neutralisation of such acids which exist in sour grass that largely contributes to make its application so beneficial on certain kinds of soil.

No other manure has ever before occasioned so great a diversity of opinion as to its value as a fertiliser. When finely ground and applied to suitable land with sufficient water either in the soil or from rainfall, the results have been most satisfactory, both in the increased yield and in the improved quality of the grass and hay; but where the conditions are unfavourable and the land unsuitable, the results have been most disappointing. Indeed, when first introduced agricultural chemists of high repute were disinclined to place any fertilising value on such a hard fused mass, however finely it might be ground, because it was so insoluble in ordinary water.

Little by little, however, farmers were induced to take small quantities for trial, chiefly on old and sour grass lands, and the practical results were so good on certain soils —rich in vegetable acids but poor in lime— that scientific authorities were soon compelled to recognise its value, and as the market price was low the material naturally became popular in certain localities.

In this country the importance of fine grinding has hitherto been recognised as the chief test of the probable manurial value, but in Germany, Professor Paul Wagner, of the Agricultural Station of Darmstadt, has insisted upon the solubility in a 2 per cent. solution of vegetable acid, such as citric acid, as a further and more definite test of probable manurial value.

Dr. Bernard Dyer, in his paper "On the Determination of Probably Available Mineral Plant Food in Soils" ("Journal of the Chemical Society," 1894), has adopted a cold 1 per cent. solution of citric acid for determining the proportions of phosphoric acid and potash existing in a presumably available form in the soil.

The present writer, however, has selected as his standard solvent a 0·10 per cent. cold solution, consisting of 1 part of citric acid to 1,000 parts of cold distilled water. Such a solution is twenty times weaker than that of Professor Wagner, and ten times weaker than that of Dr. Dyer.

In fact, it represents an acidity absolutely below that of the sap of any of the 103 plants, examined by Dr. Dyer in the paper referred to, and it also more closely approximates to the natural acidity of ordinary soils than either of the standard solutions previously employed.

It is therefore contended that any phosphoric acid, lime or potash, dissolved out by this standard solution, may fairly be regarded as existing in a form available as plant food, whether in a soil or in a manure.

In the following Table, the relative solubility in this standard solution of five different kinds of finely ground raw phosphate, is compared with that of a good specimen of basic slag.

In each case, one gramme of the ground phosphate was exhausted with 1,000 grammes of cold distilled water, in which one gramme of crystallised citric acid had been dissolved.

After standing 24 hours with occasional stirring, the insoluble portion was filtered off, ignited and weighed, while the proportions of lime and phosphoric acid were determined in the clear solution.

Mineral Phosphates.

Solubility in cold weak solution of Citric Acid (1 *in* 1,000) *after* 24 *hours.*

	French.	Algerian.	Florida.	Tennessee.	Peace River.	Basic Slag.
Total phosphate of lime present	50·86	55·99	78·26	79·57	61·23	38·97
Fine powder passed through 100 hole sieve...	76·21	67·69	72·37	91·63	93·61	83·80
Portion soluble in citric acid solution............	30·00	30·00	22·60	22·80	31·40	38·80
Containing—						
Soluble lime	15·34	13·66	11·87	11·64	15·23	22·17
Soluble phosphoric acid...	2·85	6·35	8·25	8·40	9·90	8·70
Equal to phosphate of lime	6·22	13·86	18·01	18·34	21·61	18·99

The above results show the percentage of phosphate of lime present in the respective samples, also the fineness of the grinding, the extent to which the respective specimens were dissolved by the cold, weak citric acid solution, and finally, the proportions of lime and phosphoric acid in its equivalent of phosphate of lime existing in the cold citric solution.

It will be seen that ground phosphates are only soluble, and therefore available as plant food to the extent of 22·60 to 31·40 per cent., and that the basic slag is only dissolved to the extent of 38·80 per cent., in fact only a little more than one-third of its weight, though it was of good quality, 38·97 phosphate of lime and 83·80 fineness.

As regards the actual amount of phosphate of lime dissolved out of the five specimens, the Peace River, with a fineness of 93·61, gave the highest figures for solubility, there being 21·61 phosphate of lime dissolved out of a total of 61·23.

In the case of basic slag, the figures, though relatively higher, are actually less, namely, 18·99 phosphate of lime dissolved out of a total of 38·97. These results explain why Professor Jamieson, with the black vegetable mould to experiment upon, obtained an appreciable increase in the yield of turnips from the application of finely ground raw phosphates, though if we take the most favourable example, namely, Peace River, only about one-third of the total phosphates would have been utilised as available plant food and the remaining two-thirds was of no use to the crop.

The defect in the economical application of finely-ground phosphates is their insufficient solubility, and it is this want of solubility that is the defect also of basic slag when applied to many soils.

Before leaving these figures it is interesting to notice that it is only in the proportion of soluble lime that basic slag shows a superiority over that of Peace River phosphate, there being 22·17 per cent. dissolved out as against 15·23.

Indeed, the fertilising value of ordinary basic slag must be ascribed as very largely due to the ready supply of lime when the slag is brought in contact with sour soil, if accompanied by plenty of water either in the soil or from the rainfall.

It is well known that slag fails to produce any practical results on certain soils, and this failure is probably due partly to a deficient supply of water and partly to the absence of that excess of vegetable matter which is necessary to produce an acid solvent.

THE NEW MANURE BASIC SUPERPHOSPHATE.

It occurred, therefore, to the author, after careful consideration in the autumn of 1900, that a new and useful manure could be produced by the careful admixture in suitable proportions of ordinary acid superphosphate with finely ground or slaked lime.

After making numerous trial mixtures the most suitable proportions were decided upon, and a manure was produced which possessed a distinctly alkaline or basic character, and at the same time supplied from 25 to 27 per cent. of phosphate of lime in a form readily soluble in the standard solution (1 in 1,000) of citric acid.

The manure so produced was appropriately called basic superphosphate because it combined the alkaline nature of slag with the well-known solubility of superphosphate.

The mechanical condition is superior both to that of basic slag and superphosphate. Compared with the former it is much more bulky and lighter in weight, so that if equal weights be placed in two glass tubes about 1 foot long basic superphosphate will be found to occupy a space of 11 inches as compared with only 4½ inches occupied by basic slag, the relation in round numbers being as 100 to 40.

Compared with superphosphate the new material is very much drier, containing only 4 to 5 per cent. of moisture instead of the 14 to 18 per cent. usually found in commercial superphosphate.

Being in a finely ground dry powder of light weight and bulky nature, greater uniformity and more perfect distribution can be obtained than is possible with basic slag, which when sown by hand is apt to drop between the fingers before complete delivery can be effected.

Farmers will appreciate these advantages, and will be glad to be assured that there will be no danger of any clogging of the drill from damp condition, which in the case of badly made superphosphate is a very serious defect, and renders the uniform distribution of the manure quite impossible.

The general composition of basic superphosphate may be gathered from the following analysis :—

COMPOSITION OF BASIC SUPERPHOSPHATE.

Moisture (lost at 212° F.)	4·15
Combined water and loss on ignition	12·86
*Phosphoric acid (total)	13·60
Lime	35·15
Sulphuric acid	28·50
Oxides of iron, alumina, magnesia, &c.	2·34
Insoluble siliceous matters	3·40
	100·00
*Equal to phosphate of lime....	29·68

The manure usually contains from 33 to 35 per cent. of total lime, so that in this respect basic superphosphate supplies fully 10 per cent. more lime than ordinary acid superphosphate.

The superior solubility in cold water of basic superphosphate compared with good basic slag, containing 38·97 phosphate of lime and 83·80 fineness, is shown in the following Table:—

Solubility in Cold Water after 48 *Hours,* 1 *Part Manure to* 1,000 *Parts Cold Water.*

	Basic Super.	Basic Slag.
*Portion soluble in cold water	66·80	6·60
Portion insoluble (after ignition)	33·20	93·40
	100·00	100·00
*Containing—		
Soluble lime	22·28	4·70
Phosphate of lime	None	None

It will be seen that basic superphosphate is fully ten times more soluble in perfectly cold water than well ground basic slag, the figures being 66·80 against 6·60 per cent. Further, that there is 22·28 lime dissolved out in the former against only 4·80 in the latter.

These figures may, perhaps, explain why basic slag fails on certain soils, while it produces excellent results upon others. It is not ordinary water that is capable of decomposing a hard fused mass like slag, however finely it may be ground, but water impregnated with vegetable acids. In other words, it is only on sour acid soil that special benefit may be expected from the application of slag.

It will be noticed that no phosphate of lime was dissolved out by plain water from either manure, because on account of the presence of lime in excess, all the phosphate of lime was retained in a precipitated form in the basic super, and in a more insoluble form in the slag.

*Solubility in (*1 *in* 1,000*) Citric Acid Solution (*1 *part Manure to* 1,000 *parts Solution) after* 24 *hours.*

	Basic Super.		Basic Slag.
*Portion soluble in citric solution	94·20	..	38·80
Portion insoluble (after ignition)	5·80	..	61·20
	100·00		100·000
*Containing—			
Soluble lime	34·73	..	22·17
Soluble phosphoric acid	12·45	..	8·70
Equal to phosphate of lime..	27·18	..	18·99

The above figures show that when both manures were treated in exactly the same manner, in regard to the quantity and strength of citric acid solution, with the same time allowed in each case for exhaustion with the standard solvent, basic super was dissolved to the extent of 94·20 per cent., as against 38·80 per cent. in the case of the basic slag. Further, 34·73 lime was dissolved in the former, against 22·17 in the latter. Lastly, 27·18 phosphate of lime was dissolved out of the basic super, against 18·99 out of the slag. The slag employed was the same as was used in all the previous experiments, and was of good quality and well ground. Though the slag contained 38·97 total phosphate of lime, only 18·99, or less than half, was dissolved by the standard solvent, and may therefore be considered to represent the proportion probably available as plant food.

It is very important to bear these figures in mind, and to remember that it is not the total amount of phosphate of lime present in slag that should be regarded as indicative of its manurial value, but the actual quantity that is likely to be available as plant food.

Hence, as a quick-acting manure, suitable for late application in the spring, basic super must be regarded as far superior in fertilising effect to ordinary slag, notwithstanding the high total contents of phosphate of lime contained by the latter.

The Utility of the New Manure.

Basic superphosphate can be applied, indeed has been applied in the season of 1901, with great advantage on soils deficient in lime, such as sand, gravel, granite, peat and clay.

Briefly, it may be stated that all soils containing less than 1 per cent. of lime will be greatly benefited by the application of basic superphosphate instead of slag or ordinary superphosphate.

It is is of practical importance to state that, though originally invented to supplement the deficient solubility of slag, which is fully recognised by those interested in its sale (they therefore recommend its application during the winter months), it has been found by actual field results that the new manure is superior also to superphosphate on soils deficient in lime.

Mr. William E. Bear, of Magham Down, Hailsham, employing equal quantities of basic super and ordinary superphosphate, was able to obtain a growth of radishes, 66 per cent. greater in weight by the use of the former manure, than he did by the latter.

In this case the soil contained, according to Dr. Bernard Dyer's analysis, only ·68 of lime per cent. in the dry state.

In another experiment on the farm of Mr. Ouston, near Grimsby, in Yorkshire, basic super used at the rate of 5 cwt. per acre, gave a specially good crop, and the soil on analysis was found to contain only ·78 of lime per cent.

Mr. Edward Packard, at Saxmundham, obtained by the application of 5 cwt. of basic super per acre, 18¾ tons of swedes, against 15 tons produced by 5 cwt. of slag, and 14¼ tons from the no manure plot, the soil in this case containing 1·75 lime per cent.

It is well known that soils subject to the disease known as finger and toe in turnips, are naturally deficient in lime, containing in fact considerably less than 1 per cent., and on such soils it is reasonable to suppose that an alkaline phosphate manure would naturally be a more suitable dressing than an acid phosphate manure such as superphosphate.

During the season of 1901, numerous instances were recorded in which basic super has been used on such soils with very marked advantage, the virulence of the disease being materially reduced, and in some remarkable cases in Scotland, its application has completely prevented any attack, while other parts of the field manured with ordinary superphosphate had suffered very much from the disease.

In connection with this subject, it may be convenient to point out by means of the following tabulated figures, the relation in which lime and phosphoric acid are respectively removed from the soil by ordinary farm crops.

LIME AND PHOSPHORIC ACID REMOVED PER ACRE BY FARM CROPS.

	Lime. lbs.		Phosphoric acid. lbs.	
Clover hay, 2 tons		86		25
Turnips, root, 17 tons	25·5	74	22·5	33
,, leaf	48·5		10·5	
Mangels, root, 22 tons	24·0	53	34·0	49
,, leaf	29·0		15·0	
Swedes, root, 14 tons	19·5	42	17·0	22
,, leaf	22·5		5·0	
Beans, grain, 30 bushels	3·0	33	22·5	32
,, straw	30·0		9·5	
Meadow hay, 1½ tons		28		13
Potatoes, tuber, 6 tons	3·0	26	24·0	27
,, haulm	23·0		3·0	
Oats, grain, 45 bushels	2·0	12	12·0	19
,, straw	10·0		7·0	
Wheat, grain, 30 bushel	1·0	11	14·5	23
,, straw	10·0		8·5	
Barley, grain, 40 bushels	1·5	10	15·0	20
,, straw	8·5		5·0	

It wlll be seen that in respect of an average crop of clover, hay, turnips, mangels, and swedes, lime is relatively required in greater proportion than phosphoric acid. It is useless, therefore, to expect to grow good crops, or crops free from certain diseases, if there is a deficiency of lime.

On the other hand it would appear that wheat, barley, and oats require phosphoric acid in greater proportion than lime, though the actual quantities are much less than in the case of root crops or clover hay.

This table of figures is also useful in illustrating the great waste of applying lime in large quantities, such as 3 or 4 tons per acre, for the actual crop requiremeuts would appear to be less than 100 lbs. per acre.

If 2 or 3 cwt. of superphosphate are considered sufficient to supply the requisite quantity of phosphoric acid, surely 3 or 4 cwt. of lime should be sufficient to supply the requisite quantity of lime.

Of course this remark only applies to the application of lime to ordinary well-drained soil, and not to damp sour grass land where the natural acidity of the soil would require larger dressings of lime.

But under ordinary conditions large dressings of lime are practically wasted because the slaked lime, which is not absorbed by the soil or the plant, rapidly becomes converted into carbonate of lime, in which form it is but little soluble in ordinary water.

Usually, where the soil is deficient in lime, the cost of its application is very great by reason of carriage from a distance, and in all such cases basic superphosphate will be found particularly useful and decidedly economical, because in addition to supplying from 25 to 27 per cent. of phosphate of lime in a form sufficiently soluble to afford available plant food, it also supplies an appreciable dressing of caustic lime.

How beneficial small dressings of alkaline ashes are may be inferred from the practice in India of burning the stubbles after the removal of the corn and previous to the usual rainfall.

In this country the custom of collecting and burning the common couch grass (*Triticum Repens*) is to be highly commended as being not only the most effectual way of eradicating this troublesome weed, but as being a cheap means of supplying valuable akaline ashes to the soil; for these ashes materially assist that important bacterial action whereby the inert vegetable matter of the soil is converted into valuable fertilising compounds such as nitrates.

A strong argument in favour of the utility of alkaline phosphatic manures is afforded by the fact that all the natural manures hitherto used in agriculture are distincly alkaline. Thus, farmyard manure, in the efficacy of which farmers thoroughly believe, is alkaline, and its agricultural value depends upon the extent to which the nitrogen compounds are converted by proper fermentation into ammonia salts. Guano, especially the good old Chincha Peruvian quality, is strongly ammoniacal.

Bone dust, dried blood, woollen waste and shoddy, also soot, and lastly lime, are all more or less alkaline in their nature, and certainly not acid.

Moreover, it is hardly necessary to repeat that basic slag is itself a striking instance of the utility of alkaline phosphate of lime as a manure for certain soils.

Indeed it is not natural that manures should be acid, and the reason why ordinary acid superphosphate has been beneficial to crops grown on good arable land, is that the acidity of the manure has been absorbed or neutralised by the abundance of lime usually present in such soils.

Obviously, where the soil is deficient in lime the acidity of superphosphate cannot be immediately absorbed, and harm may be done to the young rootlets of the plant.

It would require a very heavy dressing of lime to saturate the soil so completely that every square inch of surface should always contain the necessary quantity of lime requisite to absorb the acid from every particle of manure that may be brought in contact with it. In other words it is much more economical to add lime in small quantity to the manure for the purpose of immediate and complete neutralisation, than to add lime in large quantities and at long intervals to the soil in order to provide a wasteful excess of alkali for the absorption of a minute quantity of acid.

The necessity of relying upon a sufficiency of lime in the soil is entirely removed when using basic superphosphate, as by the careful admixture of an excess of lime in its manufacture all acidity is removed and the manure may be applied, mixed directly with the seed without any danger of destroying the vitality of the same.

As a practical demonstration of the injurious effects produced by the continued annual application of acid salts, it is only necessary to refer to the report on the Woburn experiments by Dr. Voelcker in the last number of the "Journal of the Royal Agricultural Society," in which a photograph is given of absolutely barren spots where the barley crop had entirely failed in consequence of the annual application of sulphate of ammonia to a ferruginous sandy soil. These barren spots were evidently due to the local accumulation of acid compounds and the absence of sufficient lime, for on the adjoining plot, which had received the same quantity of ammonia salts annually, but had in addition received a dressing of lime, the barley was looking thoroughly healthy.

On such soils as that at Woburn, basic super, which, in addition to phosphates, supplies some caustic lime, will naturally be more suitable than ordinary super, and when it is remembered that four-fifths of the former consists of ordinary superphosphate, the manufacturer will find it to his interest to supply the new manure. Indeed, on all light sandy ferruginous soils manufacturers are at present in an awkward position, because acid manures being unsuitable it follows that an alkaline manure, superior in its fertilising properties to basic slag, should be supplied, as otherwise no practical opposition to the use of slag is available.

Basic superphosphate has the advantage that it can be mixed with nitrate of soda without any fear that the valuable nitric acid will be decomposed or driven off by an excess of acid, and the resulting compound is in an excellent dry powdery condition, admirably adapted to secure uniform distribution as a top dressing.

During the season 1901, the manure has been sold in 187 places in England, 72 in Scotland, and 13 in Ireland. Many of the deliveries so included were in quantities of 10 to 20 tons, consigned to agents, so that the actual local trials have been still more numerous.

The practical results obtained in the field have, notwithstanding the dry season, been most encouraging, and have fully realised the favourable opinion originally formed from the analytical results.

CONCLUSION.

In conclusion, it should be mentioned that basic superphosphate is not intended to supersede ordinary acid superphosphate upon soils containing plenty of lime, nor is it intended to take the place of well ground slag for application to damp sour land; but it is rather intended to take an intermediate position between these two well known and most useful manures, and to be employed as a quick acting alkaline phosphate manure, specially useful as a spring dressing for crops grown upon soils that contain less than 1 per cent. of lime, the united acreage of which represent such a large area of the cultivated land in the United Kingdom.

The utility of alkaline phosphate manures when applied to certain soils has already been practically demonstrated by the great success that has attended the use of basic slag, notwithstanding its slow solubility, its frequently defective grinding, and recently, its reduced percentage of phosphate.

If therefore a material of similar alkalinity, but of greatly superior solubility, can be obtained in an unlimited quantity, and of uniform quality, it is reasonable to anticipate that basic superphosphate will prove to be a really useful and most valuable additional fertiliser.

The time has come when manures should be adapted to the soil, rather than that the soil should adapt itself to the manure.

Obviously, soils differing so much in their chemical composition and physical character, as chalk and clay, peat and sand, granite and gravel, require different manures, in the same way as they require different cultivatiou and different kinds of crops.

It is not scientific, it is not economical, and it cannot be to the advantage of the farmer, that one kind of manure should be sold for application to all kinds of soils.

Acid manures may with advantage be applied where there is plenty of lime, and alkaline manures may be more profitably applied where lime is deficient.

DISCUSSION.

The CHAIRMAN thought the Society was indebted to the reader of the paper for the way in which he had clearly placed before the audience the relative actions of various phosphatic manures when applied to different types of soil, and also for the fairness and candour with which he had stated the claims of the new substance of which he was the parent. Mr. Hughes had asked them to look upon the new manure as filling a gap which had been recognised to exist in the ordinary systems of manuring. It was well-known that on an ordinary chalky soil or on a loam of an alkaline nature superphosphates answered every possible requirements of a manure to supply phosphates. It was also known that on a great number of soils basic slag did wonders where superphosphate had been found a difficult manure to apply. But there still remained a residuum of curious failures—certain soils which did not seem to respond in the way one would expect to basic slag. It was not always possible at first sight to predict why those failures occurred. Many happened on soils, almost acid in character, which were distinctly wanting in lime, and on soils where phosphates were deficient. Certain classes of sandy and gravelly soils required both the lime and the phosphate, and yet they gave very indifferent returns when basic slag was placed upon them. That might be due to the physical conditions of the soil or want of water; but at the present time it must be accepted as an experimental fact that basic slag utterly failed to answer expectations on such soils. Mr. Hughes had put forward his particular manure as likely to be most efficacious in dealing with that class of soil. Mr. Hughes had raised the question of solubility in two senses. He had, perhaps, not distinguished enough between the solubility in water which characterised the superphosphates and the solubility in the weak acid test solution which characterised the new manure. If solubility in water had a virtue at all, it was that it ensured in the soil the distribution of the manure. Superphosphate applied to the soil was washed down by the soil water dissolved in it, and promptly re-precipitated inside the soil wherever it met with a particle of carbonate of lime, and was then re-precipitated in the same form as that in which the phosphate of lime must be present in Mr. Hughes's manure, *i.e.*, the superphosphate of a soil containing any carbonate of lime would eventually result in the precipitated phosphate under discussion, only the mere fact that it had been precipitated inside the soil from the solution formed on the surface ensured an intimate and local distribution under the soil, which could not be obtained by any form of manure spreader followed up by cultivation. That, he took it, was the great advantage which superphosphate possessed over any other form of phosphate; and the fineness of grinding which had proved to be so effective in the case of some mineral phosphates and basic slag, was an attempt to reproduce that intimate distribution in an artificial fashion. Mr. Hughes had placed before them as one of the chief tests of the merits of the manure as compared with the others the superior solubility the substance possessed in a particular solution of citric acid. While he did not wish to depreciate the value of such a test as applied to any manure, it was necessary as far as possible that laboratory experiments should be checked by experiments in the field, because the soil was an extraordinary complex body. It was very difficult to regard the soil as otherwise than simply so much inert material which would re-act as it did in the laboratory. So far from that being the case the soil was only a store-house of living organisms; and it must always be remembered that it was a medium for supplying the plant with water. There were curious differences in the surface which the soil particles possessed. The surface of a cubic foot of clay soil amounted to something like two or three acres, whereas in a sandy soil the surface was reduced down to less than one acre. There were all sorts of such curious differences on the border line between physics and chemistry in the absorption of soluble material, and in the way they would afterwards be yielded up either to the soil water or to the natural acid solvent which the sap of the plant possessed. He, therefore, considered that they should proceed slowly in deductions obtained from laboratory experiments compared with field practice; laboratory results must be checked by actual field trials. He would have been pleased if Mr. Hughes had brought forward a more exact account of some of the field trials. Mr. Hughes laid down that basic slag would only act upon, comparatively speaking, sour and acid soils which had been deprived of their lime. He was rather inclined to question that statement. Basic slag acted on a good many valuable clay soils which could in no way be described as acid soils; in fact, it was a very difficult thing to say where the acid soils began. He thought it was necessary to push the examination of an acid soil a little further than merely determining the amount of lime it contained. The laboratory with which he was connected had been for some considerable time engaged in examining not merely the lime contained in a number of soils, but the amount of that lime present in a basic condition, *i.e.*, the amount of the carbonate and the alkali earth which they contained. It must be remembered that the lime which was present in a soil must be present as a sulphate; it might be lime as silicate, but it might not be carbonate of lime, which was the base that any soil acted as a neutraliser of the acids produced by decay. He had found many fertile soils, showing no signs of sourness, which contained no measurable quantity of carbonate of lime, seeming to be in an absolutely neutral condition, having neither acid or alkali, and yet which carried very good crops. Where the bases which seemed to be necessary for so many of the vital processes came from in those soils he could not say at the present moment. He thought it was necessary to revise their classification and ideas of what constituted an acid soil, and to examine more closely with regard to the presence or absence not only of calcium, but of those carbonates of calcium which constituted the active bases of the soil. Turning to the more practical question of the use of lime, he was inclined to differ from Mr. Hughes's remarks that the calcium carbonate itself, when it was once found in the soil, was of no service. It seemed to him that it was one of the most valuable things if it got freely into solution. One of the most characteristic substances found in drainage water was calcium bicarbonate. If any lime were applied to the soil and became calcium carbonate, it was bound to circulate in the soil in the form of calcium bicarbonate. He wished to ask Mr. Hughes if he had considered whether, on the whole, it was economical from the larger standpoint to first of all make a superphosphate and then to proceed to neutralise that with lime, so to speak, to destroy the material which had already cost money. It had been his practice for some considerable time, in dealing with soils where basic slag did not seem to answer, and where, from the absence of lime, superphosphate was not likely to do much good, to make up a mixture of superphosphate with some other ground phosphate, which was left for some little time to re-act, the mixture then being applied to the soil. He always obtained very good results from such a mixture. The acid which might be on some occasions injurious in such soils had been removed in the very advantageous way of passing over more calcium phosphate. He would like to ask Mr. Hughes whether the substance might not be improved by first of all neutralising the superphosphate with a neutral phosphate, and then, if need be, adding the requisite amount of lime to produce the actual alkaline reaction. In advocating his manure Mr. Hughes was once more recalling to farmers the importance of the use of lime upon their soil, a most important consideration. Everywhere one heard that the lime kiln which used to be on the estate had now tumbled to pieces, and the farmers instead of putting lime on the land used superphosphate and phosphate of lime, thinking that that absolved them from the necessity of treating the land with occasional dressings of caustic lime or even chalk, which used to be a staple part of the routine of agriculture. It was impossible to hammer too much into farmers the fact that superphosphate and phosphate of lime were not lime at all in the sense in which caustic lime originally was used. The use of an artificial manure, so far from absolving the farmer from the necessity of using lime only made it far more necessary that he should put some base upon the soil which would neutralise the superphosphate, and combining with the acid part of the sulphate of ammonia, which provide bases for nitrication in the various manures used. Feeling very strongly how much dressings of lime were required throughout the land, he wished every strength to Mr. Hughes's elbow in the introduction of a satisfactory superphosphate.

Mr. Hermann Voss thought that the reader of the paper would agree that well-made superphosphate contained only minute traces of free sulphuric acid, the acid in superphosphate being due to free phosphoric acid. He, therefore, thought the statement should not go forth to the public that ordinary superphosphate contained such a dangerous substance as sulphuric acid in a free state. Manufacturers of superphosphate took great care that any excess of sulphuric acid should be absorbed, many thousand tons of phosphates which contained from 40 to 50 per cent. of carbonate of lime being imported into this country from Belgium for that special object. The acid, damp, and lumpy condition of superphosphates which existed twenty years ago did not exist at the present time, so that the advantages of the new manure were not so great as Mr.

Hughes had made out. The most interesting part of the paper was, that the reader of it had collected a number of facts indicating that what was really required in the soil was lime. It was necessary that a farmer, in order to utilise the manure to the best extent, should have plenty of lime on his land, by which means finger and toe disease, which was sometimes caused by an excess of superphosphate, could be avoided. Five million tons of superphosphates were used every year in the whole world; and although the use of basic slag had largely developed, it had had the effect of increasing the consumption of superphosphates.

Mr. **JOHN RUFFLE** thought the basic superphosphate to give the best results should be made very fine. He suggested as a standard, that 90 per cent. of the substance should be sent through 180 holes to the linear inch, the remaining 10 per cent. not necessarily coming up to that standard. Such a fine substance would be easily dissolved, and could be distributed through the soil better than an acid phosphate.

Mr. **F. J. LLOYD** said he had noticed of late years that the result obtained by a dressing of a certain quantity of superphosphate upon a soil had not been so great as would have been produced by the same amount of dressing if it had been applied to a similar soil 20 years ago. In endeavouring to discover the reason, he thought, if his ideas were right, he could throw some light on the question of phosphatic manures. Downing proved that lime in the soil was continually sinking, and it was known that the lime in the soil which did not sink was continually being taken away in the plant. The consequence was there was a tendency in the soil to which lime was not applied for the lime to disappear from the top surface of 6 or 8 inches in which a plant mostly lived. He believed that the soils of England today in those 6 or 8 inches were very greatly deprived of lime, and that the mere application of lime in any form to the surface would not remedy the defect. Why was it that superphosphate always gave the best result during the first year of its application; and that practically no result could be seen a year after it had been applied? He believed it was due to the fact that the phosphate in the superphosphate was soluble in water, and, being dissolved in the water of the soil, it penetrated into the soil along those courses through which the water flowed most freely. The root of a plant was always known to take the course of least resistance, which would be along those same channels. Therefore in the first year after the application of the superphosphate the plant roots travelled along those same lines on the borders of which the phosphate had been precipitated, and that was why the superphosphate gave all its results during the first year. If the soil to a depth of 6 or 8 inches was deprived of lime, the soluble phosphates from the superphosphate, instead of being precipitated along those courses which the plant root frequently took, sank into the subsoil before it met lime to precipitate it, and for that reason the same results for a definite quantity of superphosphate were not obtained because it had been precipitated too low for the roots of the plant to utilise it beneficially. For that reason he believed the introduction of a manure free from acid which would apply a phosphate of lime in a form easily assimilable by plants would prove of very considerable benefit to the farmers of England. He would have liked to deal with the question of how to estimate the availability of the substances in the soil and the substances in the manures applied to the soil; but it was perfectly evident that not only in England, but in every other country where manures were applied, the time had come when some authoritative body should lay down a definite standard which could be accepted universally as a means of estimating the available food in both a soil and a manure.

Dr. **S. RIDEAL** thought it was by no means proved that basic slags were at a disadvantage compared with the neutralised phosphate suggested by Mr. Hughes. The use of slag had increased enormously in recent years, due probably to the fine grinding, and when one compared the ratio of slag used in Germany, to that of superphosphate in England, one must conclude that basic slags had the disadvantages one was led to imagine existed. Basic slags certainly had an alkalinity similar to that claimed by Mr. Hughes, and it would be interesting to know whether Mr. Hughes had any definite opinion as to what the definite phosphate was which existed in his neutralised superphosphate. With regard to the question of manufacture, was it not feasible that if there was a basic slag which was alkaline and acid superphosphates which had injurious effects upon soils deficient of lime, then a mixture of the two ground together would bear out the theory propounded by Mr. Hughes. There was no occasion to convert the mineral phosphates into superphosphates. The Germans had already realised that point in the tremendous [growth of the Thomas slag, and the deficiency of the pig-iron in phosphorus had led the German manufacturers to add mineral phosphates so as to produce a slag rich in phosphate. That seemed to him to be a method by which the native mineral phosphates could be converted into a basic slag phosphate suitable for use. The question to be considered was whether it was the ratio of lime to phosphate which caused the beneficial results. Although lime, phosphate, and nitrogen were elements of plant life, potash was also a very important constituent. Potash was an alkaline body which could be used for neutralising the superphosphate, and a mixture would then be obtained containing lime and potash which, he believed, would be superior to the mixture suggested by the reader of the paper. If the potash statistics were inquired into abroad as compared with England, it would be found that the increase in the Thomas slag had been accompanied in Germany and France by an enormous development in the use of potash manures. The land in this country was starved of potash. He thought the problem ought to be studied in relation to the alkaline phosphates, and not merely in connection with lime phosphates of unknown alkalinity.

Mr. **EDWARD PACKARD** thought there was no commercial form of potash which could be applied as an alkali to produce the action suggested by Dr. Rideal. The Chairman had asked why the reader of the paper had not given a larger number of authenticated results of the experience of last year. The fact was, that when the basic superphosphate was brought before those in authority who had opportunities of making experiments, they took no notice of it. He thought Mr. Hughes had proved that the basic super might prove a valuable adjunct, under certain circumstances, to the soil of the country. In some experiments, in which he had tried the basic superphosphate with nitrate of soda and potash, as against superphosphate, sulphate of ammonia, and potash, the results were astonishingly in favour of the basic superphosphate. Experiments were being carried on, and, in course of time, results of great value would be published.

Mr. **JAMES HUDSON** said that for years past he had been impressed with the fact that fruit growers made too free use of nitrogenous manure, especially in growing tomatoes. He had proved over and over again that regular successions of crops of cherries could be grown by the use of phosphatic manure, finely ground, as suggested by Mr. Hughes. He agreed that the constituents of the soil must be known before the right artificial manure could be applied.

Dr. **TEED** expressed the opinion that Mr. Hughes's discovery would be of the greatest benefit to the agriculture of the country.

Mr. **D. A. LOUIS** thought Mr. Hughes's suggestion of mixing lime with a superphosphate was exceedingly valuable, because it enlarged the scope of the superphosphate. It made it appropriate to many soils, where it would otherwise have been very harmful.

Mr. **HUGHES**, in reply, said the Chairman had alluded to certain cases in which the soil, although not deficient in lime, had given good results by the use of basic slag, but had afterwards stated that the soil was clay. It was well known that clay had the property of holding water to a considerable extent, and in his paper he laid great stress upon water as a factor in rendering slag soluble. He was, therefore, not surprised that it gave good results on clay. Further, bicarbonate of lime was often found in water; certainly as carbonic acid it usually came from decomposed organic matter; and if it so happened that organic acid came in contact with lime in the soil, one might be quite sure that the water that passed away from the soil was largely impregnated with carbonate of lime. The Chairman and other speakers had suggested the mixture of raw phosphate with the super. The object of mixing lime was to neutralise the acidity of the superphosphate; and if a material costing only 18s. or 20s. a ton in the form of lime could be used, why should raw phosphates, which cost £3 a ton, be used? Assuming that raw phosphates were used, the tables showed the extent to which they were acted upon by the weak solution of citric acid; only one-third of the phosphate would be saturated by the acid, two-thirds being wasted. He could not understand the remarks made in advocating the use of lime. He endeavoured to lay down very clearly that it was far more expensive to supply sufficient lime, so that every square inch of a field should contain enough lime to neutralise any acid, brought in contact with it. After adding about 20 per cent. of lime to the superphosphate, sufficient to neutralise all the acid and produce a slight excess in order to give it a distinctly alkaline character, everything was done that was required. He thought, therefore, the mixture of lime and superphosphate was one of the most profitable ways in which lime and phosphate could be applied to ordinary soils. He quite agreed with Mr. Voss, that any acidity in the superphosphate was due to the presence of free phosphoric acid and sulphuric acid. He top-dressed a row of peas with superphosphate and nearly killed them, which led him to the conclusion that there must be conditions in which superphosphate used as a top-dressing was anything but beneficial. If it was injurious to the leaf, he submitted the acidity was equally injurious to the small rootlets of the plant, and on that principle his manure ought to be beneficial. Although basic slag was only soluble to the extent of 6 per cent. in ordinary water there had been a great demand for it; it had been of very great benefit, and many farmers were thoroughly satisfied with it. When slag was brought out the practical manure manufacturers all discarded it, and yet without any recommendation it had forced its way forward and demonstrated that an alkaline phosphate was the best form in which phosphates could be applied. No criticism had been offered on his remark that all the natural manures of the farm were alkaline and not acid, a point of great importance. Surely they must do well if nature was followed as a guide. He thoroughly believed in superphosphate and did not wish to detract from its merits, but its use should be restricted to soils which contained plenty of lime, just as basic slag was confined to soils which were particularly sour, and the new manure to intermediate soils. As time went on, with judicious use, it would be found there was plenty of room for all the manures.

On the motion of the **CHAIRMAN**, a vote of thanks was accorded to Mr. Hughes for his paper.

Obituary.

B. F. Stevens, F.S.A.—Mr. Benjamin Franklin Stevens, who was the Official Despatch Agent of the United States Government in London, from 1866, died at his residence on Surbiton Hill on the 5th inst. He was born at Barnet, Vermont, February 19th, 1833, and settled in London as a young man, following to England, his brother, the late Henry Stevens, the eminent bibliographer. He married in 1865, Charlotte Whittingham, the oldest daughter of the second Charles Whittingham, the well-known printer, and for a few years, before the death of his father-in-law, in 1876, he was a partner in the Chiswick Press. He was Chairman of the American Society in London during the first year of its existence, and subsequently its honorary treasurer. At the last meeting of the general committee, a resolution was passed deploring the death of a colleague, "who, while always loyal to his native land, was a devoted friend to the country in which the greater part of his life was passed, and whose constant care was the promotion of friendship between the people of the two communities." Mr. Stevens was elected a member of the Society of Arts in 1897.

Lord Malcolm.—John Wingfield Lord Malcolm of Portalloch, a member of the Society of Arts since 1861, died at Hyères, France, on Thursday, 6th inst. He was born in 1833, the son of Mr. John Malcolm of Portalloch, and was educated at Eton and Christ Church, Oxford. From 1860 to 1880 he sat in the House of Commons as the Conservative member for Boston, and from 1886 till 1892 he represented Argyllshire, and in the latter year he was made a C.B. In 1896 he was raised to the peerage as Lord Malcolm of Portalloch. He had been Captain of the Kent Artillery Militia, and at the time of his death was honorary Colonel of the 5th Volunteer Battalion, Argyll and Sutherland Highlanders.

Sir Thomas Charles Lucas, Bart.—Sir Thomas Lucas, partner for many years in the firm of Lucas Brothers, afterwards Lucas and Aird, died at his house in Kensington-park-gardens, on the 6th inst. He was born in 1822, and was created a Baronet in 1887. He took much interest in the Volunteer movement, and was Major and Hon. Lieutenant-Colonel of the Engineer and Railway Volunteer Staff Corps. Sir Thomas Lucas was elected a Member of the Society of Arts in 1861.

Abraham Haworth, J.P.—Mr. Haworth, head of the firm of James Dilworth and Sons, cotton yarn merchants, died on Sunday, 9th inst., at Hyères. He had been a Member of the Society of Arts since 1872. Mr. Haworth was a leading figure in Manchester commercial life, and in local philanthropic movements.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

March 19.—"Electric Traction. London's Tubes, Trams and Trains." By J. Clifton Robinson, Assoc.Inst.C.E., M.I.E.E.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

April 17.—"Recent Developments in Punjab Irrigation." By Sidney Preston, A.M.Inst.C.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab.

May 1.—"The Past and Present Connection of England with the Persian Gulf." By Thomas Jewell Bennett.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

March 25.—"The Sphere of State Activity in Australia." By the Hon. Sir John Alexander Cockburn, K.C.M.G.

April 22.—"British Commercial Prospects in the Far East." By Byron Brenan, C.M.G., late H.M. Consul-General at Shanghai.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

April 8. 8 p.m.—"Street Architecture." By Beresford Pite, Professor of Architecture, Royal College of Art, South Kensington.

May 6.—"The Printing and Illustration of the Modern Book." By Charles T. Jacobi.

May 27. 8 p.m.—"The Decoration of the Pianoforte." By Charles C. Allom.

CANTOR LECTURES.

J. D. Geddes, "Application of Photography to Printing." Three Lectures.

Lecture III.—March 17.—Trichromatic photography—General principles—The preparation of blocks for printing in colours—Direct and indirect processes—Printing inks and printing machines—Application of the three-colour process to artistic and commercial illustration.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. D. Geddes, "Photography as Applied to Illustration and Printing." (Lecture III.)

Society for the Encouragement of Fine Arts, 8 p.m. Conversazione in the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W.

Imperial Institute, South Kensington, 8½ p.m. Mr. H. Greenwood, "Home Life in Canada."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Sidney K. Greenslade, "The Planning of some Recent Library Buildings in the United States."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace W.C., 4½ p.m. Dr. Walter Kidd, "Adaptation and Selection in Nature, and their Bearing on the Evidence of Design."

TUESDAY, MARCH 18...Royal Institution, Albemarle-street, W., 3 p.m. Prof. L. B. Poulton, "Recent Researches on Protective Resemblance, Warning Colours, and Mimicry in Insects." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 1. Discussion on papers by Messrs. W. M. Mordey and Bernard M. Jenkin. 2. Mr. W. C. Copperthwaite, "The Greenwich Footway-Tunnel." 3. Mr. Arthur H. Haigh, "Subaqueous Tunnelling through the Thames Gravel: Baker Street and Waterloo Railway."

Statistical (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 5 p.m. Sir Robert Giffen, "A Financial Prospect."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Hans Gadow, "The Evolution of Horns and Antlers." 2. Lt.-Col. J. M. Fawcett, "Notes on the Transformations of some South African Lepidoptera." 3. Mr. R. I. Pocock, "A New Stridulating Organ in a Scorpion."

WEDNESDAY, MARCH 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Mr. J. C. Robinson, "Electric Traction—London's Tubes, Trams and Trains."

Naval Architects, (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 11 a.m. Annual Conference. 1. Address by the Chairman, the Earl of Glasgow. 2. Mr. Sydney W. Barnaby, "Torpedo Boat Destroyers." 3. Mr. Ivan G. Boobnoff, "The Stresses in a Ship's Bottom Plating due to Water Pressure."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. W. N. Shaw, "'La Lune mange les Nuages.'—A Note on the Thermal relations of floating Clouds." 2. Mr. Frederick J. Brodie, "The Prevalence of Gales on the coasts of the British Islands during the 30 years 1871-1900."

Microscopical, 20, Hanover-square, W., 7½ p.m. Exhibition of Foraminifera, by Mr. A. Earland.

United Service Institution, Whitehall, S.W., 3 p.m. Mr. A. N. Colquhoun, "Colonisation and Sea Power."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Dr. Frederick A. Dixey. "Notes on some cases of Seasonal Dimorphism in Butterflies" (with an account of Experiments made by Mr. Guy A. K. Marshall). 2. Professor E. B. Poulton. "Mimicry illustrated by the Sanger Shepherd three-colour process."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Chemical, Burlington-house, W., 5½ p.m. 1. Prof. W. N. Hartley, "The Absorption Spectra of Metallic Nitrates." (Part I.) 2. Messrs. H. M. Dawson and F. E. Grant, "A Method of Determining the Ratio of Distribution of a Base between Two Acids." 3. Mr. H. M. Dawson, "The molecular complexity of Acetic Acid in Chloroform Solution." 4. Messrs. H. M. Dawson and R. Gawler, "The existence of Polyiodides in Nitrobenzene Solution." 5. Mr. F. D. Chattaway, "Nitrogen Chlorides containing the Propionyl Groups." 6. Messrs. A. Lapworth and A. W. Harvey, "Derivatives of *a*-aminocamphoroxime." 7. Messrs. E. Divers and M. Ogawa, "Preparation of Sulphamide from Ammonium Amidosulphite." 8. Mr. R. L. Taylor, "Hypoiodous Acid."

THURSDAY, MARCH 20...Royal, Burlington House, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. J. C. Bose, "Electric Response in Ordinary Plants under Mechanical Stimulus." 2. Dr. A. Staff, "The Fruit of *Melocanna bambusoides*." 3. Messrs. Alfred O. Walker, and Andrew Scott, "Malacostraca from the Red Sea collected by D. H. A. Forbes."

Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C. 12 p.m. 1. Sir J. Fortescue Flannery, "Liquid Fuel for Ships." 2. Captain G. Russo, "The Navipendular Methods of Experiments, as applied to some Warships of different Classes." 3. Professor J. H. Biles, "The necessity for Fixing a Standard of Stability for Sea-Going Ships." 7 p.m. 1. Professor Stanley Dunkerley, "The Straining Forces in Crank Shafts." 2. Herr L. Gümbel, "Torsional Vibrations of Shafts." 3. Mr. A. Scott Younger, "Improvements in Propeller Shaft Bearings."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. T. Reed, "Caricature In and Out of Parliament." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Papers on Electric Shock. 2. Messrs. James Swinburne and W. R. Cooper, "Problems of Electric Railways."

Historical, Clifford's-inn, Fleet-street, E.C. 5 p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MARCH 21...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C. Annual Conference. 1. Mr. W. Laird Clowes, "Modern Scientific Developments and the Future of Naval Warfare." 2. Mr. C. E. Stromeyer, "Distortion in Boilers due to Overheating." 3. Prof. E. Cohen, "The Corrosion of Condenser Tubes and Sea-water Conductors."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Geheimrath Prof. Otto N. Witt, "Recent Developments in Colouring Matters." (In English.)

North-East Coast Institute of Engineers and Shipbuilders, South Shields, 6 p.m. 1. Mr. W. A. Fairburn, "The Methods of Handling Material over Shipbuilding Berths in American Shipyards." 2. Prof. W. E. Dalby, "A Comparison of Five Types of Engines with respect to their Unbalanced Forces and Couples." 3. Mr. J. Macfarlane Gray, "A Note on Simpson's Rules."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. 1. Mr. Henry D. Marshall, "Fencing of Steam and Gas-Engines." 2. Mr. Samuel R. Platt, "Fencing or Guarding Machinery used in Textile Factories." 3. Mr. Henry C. Walker, "Protection of Lift Shafts, and Safety Devices in Connection with Lift Doors and Controlling Gear." 4. Mr. W. H. Johnson, "Guarding Machine Tools."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Architectural Assoc., 9, Conduit-street, W., 7½ p.m. Mr. W. H. Lever, "The Dwellings erected at Port Sunlight and Thornton Hough."

SATURDAY, MARCH 22...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Some Electrical Developments." (Lecture VI.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Tuesday, March 25, 4.30 p.m. (Colonial Section.) The Hon. Sir John Alexander Cockburn, K.C.M.G., "The Sphere of State Activity in Australia."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 17th inst., Mr. J. D. Geddes delivered the third and last lecture of his course on "Photography Applied to Illustration and Printing."

On the motion of the Chairman (Sir William H. Preece, K.C.B., F.R.S.), a vote of thanks was awarded to the lecturer for his course of lectures.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

The reading of Mr. Byron Brenan's paper on "British Commercial Prospects in the Far East," announced for Tuesday, April 22, has been unavoidably postponed in consequence of Mr. Brenan's absence from England.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

The Council of the Society of Arts have determined to add to the existing system of examinations, *vivâ voce* examinations in modern languages. At present it is proposed to hold such examinations in French, German, and Spanish; other languages will be added as soon as a demand arises. It is the hope of the Council, that eventually it may be possible to require all candidates in modern languages to pass a *viva voce* examination, as well as a written one, and to restrict the issue of certificates to such candidates.

The examinations will be held at any date, at any of the Society's examination centres, where the local Committee will undertake to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate, for not less than 24 candidates. Unless as many as 50 candidates are entered, the local Committee will also be required to pay the examiner's travelling expenses, including first-class railway fare from London, to the place where the examination is held. The Committee will also be required to defray all the local expenses, and to provide a convenient room for the examination, together with a suitable waiting-room for the candidates. To cover such expenses an additional fee may be charged. Such arrangements may be made as may be convenient for the simultaneous examination of all or part of the candidates in Dictation. Except as regards the Dictation part of the examination, no person, except the examiner and the candidate under examination, should be allowed in the examination room while the examination is going on.

The examination will include Dictation, Reading, and Conversation. Candidates will be expected to satisfy the examiner in all these branches. Candidates who do so will receive a certificate of proficiency in Colloquial French, German, or Spanish, if, in the opinion of the examiner, they can express themselves fluently in the language selected; minor grammatical errors will not prevent success. The candidate's grammatical knowledge will be tested, as hitherto, by the written examinations of the Society in modern languages.

The examination might be held for 2½ hours in the morning, 2 hours in the afternoon, and 2 hours in the evening. It is calculated that an examiner will be able to examine eight candidates per hour, or about 50 per diem. But the time and duration of the examination can be arranged to suit the convenience of the local Committee, on the understanding that it does not last for more than 6½ hours in all, with suitable intervals.

In order to secure uniformity of standard, it is intended, at all events for the present, that all the examinations in each language shall be conducted by the same examiner.

The Committees of different local centres may, of course, combine together for the purpose of holding a joint examination in their locality.

In order to afford accommodation to the students of Institutions who may wish to send in a few candidates for the above examinations, but may not have a sufficient number to justify their holding an examination of their own, the Technical Education Board of the London County Council has arranged for the organization of a London centre for the *viva voce* examinations only. The Secretary of the Board, Dr. William Garnett, is now prepared to receive applications for these examinations from the Secretaries of Public or Endowed Schools, Polytechnics, Technical Institutes, or similar institutions.

As soon as it is known that a sufficient number of candidates are likely to present themselves in each subject, a convenient date will be selected, and the necessary arrangements made for holding an examination in French, in German, and in Spanish.

Any Institutions which can send in a sufficient number of candidates, and would therefore naturally prefer to have the examination conducted on their own premises will not be affected by this arrangement.

Secretaries of local Committees desiring to hold *vivâ voce* examinations should write to the Secretary of the Society of Arts, Adelphi, London, W.C., for a form on which to make application.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1902 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 5th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For.Memb.R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For.Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For.Memb.R.S. Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (now Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Prof. David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

In 1899, to Sir William Crookes, F.R.S.

In 1900, to Henry Wilde, F.R.S.

In 1901, to HIS MAJESTY THE KING.

A full list of the services for which the medals were awarded was given in the number of the *Journal* for March 7.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 6, 1902; The Right Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, in the chair.

The paper read was—

THE COAL RESOURCES OF INDIA AND THEIR DEVELOPMENT.

By PROFESSOR WYNDHAM R. DUNSTAN, M.A., F.R.S., Sec.C.S., F.I.C.,
Director of the Scientific and Technical Department of the Imperial Institute.

It is unnecessary to dwell upon the importance to any country of an enormous supply of coal, since coal for the present, at any rate, is the principal source of mechanical power both on land and at sea. The general prosperity of a nation must be intimately bound up with a cheap supply of coal, for not only is it required for ships and railways, factories and mills, but it is essential to some of the greatest of our metallurgical industries, and is, moreover, an important means of employing labour. The question of the coal resources of our own country has been always regarded as a vital one by our economists and manufacturers. The larger question of the coal resources of our colonies and dependencies throughout the Empire has, however, not yet received the attention it deserves, closely connected as it must be with the prosperity of the nation as a whole. Now that reciprocity in trade and Imperial Defence are regarded as political ideals, it is to be expected that our knowledge of the coal supplies of the Empire may be put upon a sound basis.

Of all our dependencies none deserves more consideration than India. Every British statesman has recognised the importance of promoting the industrial development of this great country with its splendid stores of mineral wealth, yet for the most part undeveloped, and its unrivalled forests of vegetable produce. Nothing can contribute more powerfully to this end than the opening up of new coal resources, and the provision of such satisfactory methods of transport and communication that the products of the mines shall become available for use all over India, and for export to the principal ports of the Eastern World.

That India possesses a practically inexhaustible supply of coal is a fact but little known in this country. The history of the development of coal mining as an industry is brief and comparatively recent. Although several collieries were working in 1837 supplying a small local demand, it was not until 20 years later, under the beneficent reign of Lord Dalhousie, that the enterprise showed signs of the development which has now made it an important factor, not only in Indian, but in Imperial affairs. In 1880 the output from the Indian mines had just exceeded 1,000,000 tons, about 98 per cent. of which was produced in Bengal, whilst the remainder was taken entirely from the Central Provinces. In 1900 the output from the Indian collieries exceeded 6,000,000 tons, and whilst Bengal contributed nearly 5,000,000 to the total, Burma, Assam, Central India, the Punjab, Baluchistan and the Nizam's Territories, in addition to the Central Provinces, figure as important producers, the Nizam's Dominions alone contributing nearly half-a-million tons, this province now standing next to Bengal in its output of coal (Appendix, Table I.). As will be seen from the Table (Appendix, Table II.) the Indian output now exceeds that of any British dependency, although New South Wales and Canada are near with outputs of over 5,000,000 tons, being about the same as that of Bengal. The Indian output is about 1-35th of that of the United Kingdom and Ireland.

For some years an increasing quantity of foreign coal was imported into India. Between 1885 and 1895 it varied between 600,000 and 800,000 tons per annum, most of it shipped from the United Kingdom, some from Australia and Japan. Japan has been sending an increased amount of coal to India, much of which, however, is said to be of inferior quality. In the last few years, the imports of coal into India have fallen considerably, and in 1889 they had sunk to 422,376 tons, and for 1900 the figure was only 127,318 tons, including coke and patent fuel (see Appendix, Table III.). This fall is to be accounted for partly by increased internal production and facilities for transport, partly by the rise in the price of British coal, consequent chiefly on the export tax. It is to be remarked that most of the imported coal goes to Bombay for use in mills and factories, Bombay being far removed by sea or land from the coalfields. There can be hardly a doubt, that as means and conditions of coal transport are improved, the import of foreign coal will entirely cease, and this may be expected to occur within a very few years.

The exports of coal from India tell an entirely different story. In 1892, India, chiefly Bengal, exported 15,620 tons, in 1896 the amount had risen to 136,719 tons, whilst in 1900 the figure is 541,445 tons (see Appendix, Table III.). It is interesting to note that of this large quantity, Colombo took 369,000 tons, Singapore 66,000 tons, and Aden 53,000 tons. Colombo is an important coaling station, which formerly did not take much Indian coal; now, however, it is extensively employed, and is also burned on the Ceylon railways.

The internal consumption of coal in India has greatly extended. It is now burned on nearly all the Indian railways, some of the railway companies having their own mines. There can be no question, that with cheaper and better means of transport it will be possible to start several new industries depending on the use of coal. Of these, by far the most important will be iron and steel production from the abundance of excellent iron ore to be found in India. This is a momentous question for India, but I cannot do more than refer to it generally in this paper.

With these general remarks on the present production of coal in India, I pass to consider more in detail some important points such as the distribution and nature of Indian coal. These subjects were briefly discussed in the "Report on the Coal Supply of India," which I made at the instance of the Government of India in 1898. This Report included the preliminary analytical and technical examination of a large number of samples of coal taken from all the principal seams in India, which were carried out in the Research laboratories of the Scientific and Technical Department of the Imperial Institute, with the object of determining which coals were deserving of more complete investigation. (See Appendix, Table V.)

DISTRIBUTION OF COAL IN INDIA.

The coal measures in India belong to a geological period considerably more recent than that in which the coal measures of the United Kingdom and Europe are deposited. In the Indian peninsula the coal is of the permio-triassic age, and belongs almost entirely to the lower Gondwana period. This includes the Bengal coalfields. Outside the Indian peninsula the coal is still more recent, mostly belonging to the tertiary age. This coal is probably less widely distributed than that of the older series, but it occurs in very thick deposits in Upper Assam. Considerable deposits of cretaceous coal also occur both in Assam and Bengal. In connection with the development of the coal resources of India, it is important to bear in mind that coal does not occur at all outside the region of these geological formations, and that, therefore, no considerable quantity of genuine coal is likely to be discovered in Southern India, including Madras and Mysore, where the geological formations are for the most part of older date than those which in India bear coal. True coal is not likely to be found in any quantity in Bombay, except perhaps at great depths, and geologists generally are of opinion that it is not to be expected below the alluvial deposits of Sind, the North-West Provinces, and Rajputana.

The difference in age accounts to a large extent for the difference in character shown by peninsular and extra-peninsular coal. Taking the Bengal coal as a representative of the former, it is somewhat bituminous, with a rather high percentage of mineral constituents (ash). This coal often furnishes a good coke. The tertiary coal of Assam, representing the extra-peninsular deposits, is usually soft and bituminous, containing a high percentage of volatile constituents (hydro carbons) and much less mineral matter than Bengal coal. Some of this coal also forms good coke.

The Upper Gondwana (Jurassic) coal of the peninsula is at present of little importance; the seams are usually thin, and the coal of inferior quality.

Deposits of lignite occur scattered throughout the Himalayas and elsewhere, but these are at present only of secondary importance.

No accurate statement can be made as to the total amount of coal which occurs in India, chiefly owing to the want of information as to the exact extent of some of the fields, and of the thickness of the seams. Geologists are inclined to put the total coal area as occupying about 35,000 square miles. Having regard to the extreme thickness of many of the seams, which sometimes exceed 100 feet, it is clear that India possesses, even after all allowances have been made for difficulties of working and other deficiencies, an enormous supply of fuel which will soon render her independent of other sources of supply, and which in time to come may even be drawn upon by other nations whose coal deposits are now in process of depletion.

PROVINCIAL COALFIELDS AND COLLIERIES. CHARACTERS OF COAL.

We may now consider the more important coalfields, and the collieries which have been established in them.

Bengal.—In 1900, 238 collieries were at work, the output being nearly 5,000,000 tons.

The principal coalfields in this province are those of Karharbari (Giridih), Raniganj, Jheria, and Karanpura. Karharbari (Giridih), 200 miles from Calcutta, covering about eight square miles, is estimated to contain 136,000,000 tons of coal. The collieries in this field are served by the East Indian Railway Company, which itself works some of the pits. The most important seam is the lower seam, which occupies an area of about seven square miles, and varies between 12 and 30 feet in thickness. Some of the pits are very deep; in one case reaching to 650 feet. From the Table of Analyses appended (Appendix, Table V.), it will be seen that Karharbari coal is of good quality, the fixed carbon in some cases amounting to nearly 67 per cent., with from 5 to 10 per cent. of ash, and a calorific equivalent of about 7,000 calories. It is a good steam coal, and some of it cokes well.

The Raniganj-Barakar field is about 130 miles from Calcutta, and is one of the most important in India. It extends westward along the valley of the Damuda River, and is virtually enclosed by the rivers Damuda and Adjai. The East Indian Railway, running from Calcutta to Patna, passes through the middle of the field. It covers 500 square miles, not including the dip below the alluvial bed to the east. The amount of coal it contains is estimated at 14,000,000,000 tons. The seams vary in thickness. The field is worked by numerous collieries. The coal contains, as a rule, between 50 and 60 per cent. of fixed carbon, about 10 per cent. of ash, whilst the calorific value lies between 5,000 and 6,000 calories. The Sanctoria is a good coal of this series, and cokes well. The coal of the Desherghur seam is held in high repute in India. Seebpore coal is also largely used.

The Jheria field is about 16 miles to the west of that of Raniganj. It is connected with the main line of the East Indian Railway by a branch terminating at Jheria and Katrasgarh. The field has an area of about 200 square miles, and is supposed to contain 864,000,000 tons. Its coal is of the Raniganj and Barakar series, and several of its seams yield a good steam coal resembling that of Karharbari. Though the samples analysed (see Appendix, Table V.) are inferior in yielding much ash, it appears that the coal, as generally mined, is of better quality.

The Bokara field is about two miles west of Jheria. It covers 220 square miles, and is estimated to contain 1,500,000,000 tons; some of the seams are very thick.

There are several other fields in Bengal not yet developed or connected with the railway which are capable of furnishing large quantities of coal.

These are North Karanpura 472 square miles, containing 8,750,000,000 tons, and South Karanpura representing about 75,000,000 tons. The Karanpura fields, situated at the head of the Damuda Valley, are difficult of access, being hemmed in by hills and not yet connected with the railway. The coal is stated to be of good quality, and this field may become of considerable importance in the future, as iron ore of excellent quality is said to occur near the coal measures.

Smaller fields or coal areas are those of Ramgarh, Daltonganj (Palamow), Talchir, and Rajmahal, not at present worked to any extent, but some appear to furnish fair steam coal. (See Appendix Table V.) Railway communication with these fields is needed.

Important additions to the railway communications within the Bengal fields have been recently sanctioned by Government. The Grand Chord of the East Indian Railway is to be completed by a line from Gya to Katrasgarh, a distance of 112 miles, thus giving additional connection with the Jheria field. The Bengal-Nagpur Railway is to extend by a new main line from Midnapur through Bishenpur to Bugudih, bridging the Damuda River, and connecting with the local lines within the field.

A branch line from Katrasgarh to the coalfields of Daltonganj (Palamow), passing through the intermediate coal areas and connecting with the new line of the East Indian Railway from Some River junction to Daltonganj, would be of great assistance to the further development of this important coal district.

In the Darjiling district, on the frontier of Nepal, there is a narrow field of anthracitic coal much crushed and very friable, and probably unworkable on the large scale. If made into briquettes, it furnishes a useful steam coal, and it is also said to make good coke. This seems to be the nearest approach to Welsh coal which so far has been found in India. A sample from Rakti Naddi, analysed by the Geological Survey, contained nearly 80 per cent. of fixed carbon. Further exploration of this district, between the Lisu and Ramthi rivers, has disclosed a field of about 97 acres, containing about 5,500,000 tons of coal, some of the seams being from 16 to 20 feet thick. This coal furnishes coke, and contains, on an average, 61 per cent. of fixed carbon, and about 12 per cent. of ash.

In connection with the establishment of an iron and steel industry in India, the question of the coking qualities of the Bengal coal is a matter of considerable interest. Coke has been made for some years at Barakar for use in the Bengal ironworks, which have been recently successful in smelting iron from the local ore. This coke, however, is chiefly produced in open ovens, and modern methods do not seem to have been permanently adopted either in respect of washing the coal, or manufacturing the coke. The coke appears to be of inferior quality, being deficient in strength, whilst the percentage of ash ranges as high as 15 to 24 per cent. This question has been fully and ably inquired into by Major R. H. Mahon, R.A. ("Iron and Steel Manufacture in India," Simla, 1899.) The soft coals of the Raniganj-Barakar series, such as that of Sanctoria (Desherghur seam), were found not to produce a satisfactory coke, but those of Giridih and Jheria (Kenwadih and Kustore), when efficiently washed and coked in a closed oven, furnished an excellent hard coke, containing little sulphur, and yielding from 10 to 12 per cent. of ash, which, though higher than that of English coke, would not be an obstacle to its use if the phosphorus in it is not excessive (see Appendix, Table IX.). In fact, the coke so produced seems, from Major Mahon's account, to leave little to be desired from a metallurgical point of view, and should be well adapted for the manufacture of iron and steel. The cost of production is calculated as not exceeding Rs. 4 a ton on the spot.

Central Provinces.—In 1900 eight collieries were at work, the output being 172,842 tons.

In the West, the two principal fields are those of Mohpani and Warora. Owing to the position they occupy midway between Bombay and Bengal, the coal of their fields is likely to hold an important place. They are both connected by branches with the Great Indian Peninsular Railway.

The Mohpani field is rather less than 100 miles from Jabulpore, and 322 miles from Allahabad; everything points to Jabulpore becoming in the future an important industrial centre. The area of the field is not great and the output small. Difficulties are said to have been encountered in working this field. The samples of coal examined (see Appendix, Table V.) were of fair quality. They did not form coke, except those from seams 2, 3 and 4.

The Warora field has an area of about 420 acres, and is estimated to contain about 20,000,000 tons, not including a much larger area (Ghajas, Wun, &c.), at present unworked. The seams vary in thickness from 12 to 13 feet.

The Great Indian Peninsular Railway is connected with the field by a branch line from Wardha, 60 miles in length. Nagpur is about 120 miles, and Bombay 500 miles distant by rail. It has been proposed to carry a line from the Nizam's State Railway through the field which would bring it within 400 miles of Masulipatam. The mines are owned by Government, and nearly the whole output is taken by the Great Indian Peninsular Railway. The samples received varied much in quality, and were in general distinctly inferior to Bengal coal.

Some of the Mohpani coal of this province appears to coke, a point which should be further examined as being of great importance in connection with the alleged occurrence of good iron ore and limestone in the district. For this reason the whole of this region deserves attention. Other small coalfields occur here, as those of the Satpura district, and Shahpur and Pench. The coal is little known, but further development is now possible through the branch line of the Bengal-Nagpur Railway to Chindwara.

To the East, adjoining the Bengal fields, are several coal areas deserving attention. In the Mahanadi Valley there are the fields of Korba, Mand, Talchir, and Raigarh-Hingir, covering an area of about 1,000 square miles, the coal of which is also little known, but is stated to be of good quality. The Rampur field on the Eeb River to the north-west of Sambalpur has been recently re-examined, and appears to furnish a good steam-coal, which should be further investigated. It is desirable that these fields should now be brought into railway connection.

Central India.—In 1900 only one mine was in active working, the output being 164,489 tons.

The most important field of this district, and the only one at present worked, is that of Umaria, which is 34 miles from Katni on the Great Indian Peninsular Railway, and connected by a branch line. The field has an area of about three square miles, and is estimated to contain 28,000,000 tons of coal. The samples examined (see Appendix, Table V.) show that the seams vary in quality; some of the coal previously examined is better than the present sample. None of the coal appears to form coke. Other fields of this district are Sohagpur (Singrowli), through which a branch line of railway now runs connecting Katni on the East Indian Railway and Bilaspur on the Bengal-Nagpur line. The coal of the fields of Korar, Johilla, and Bisrampur (Sirguja, strictly in Bengal), appears to be similar to that of Umaria, but requires further investigation.

Nizam's Dominions (*Hyderabad*). — In 1900 five collieries were at work, producing 469,291 tons.

This territory contains coal chiefly of the Barakar series. The largest field and the only one systematically worked is the Singareni in the Godavari Valley, which occupies about eight square miles, and contains about 36,000,000 tons of coal. There are a number of seams, one over 40 feet in thickness. The collieries show an increasing output, and do a considerable trade both with Madras and Bombay. The field is connected by a branch line with the Nizam's State Railway, whence Masulipatam is 146 miles, and Bombay 653 miles distant. Railway and canal communication can also be had with Madras, 350 miles away. Singareni coal has a good reputation as a steam coal. The samples examined were of fair quality, giving a moderate amount of ash, and a fairly high calorific value (see Appendix, Table V.). The coal appears to coke very slightly, if at all. The coal of other fields of this district (Kamaram, Chinar, &c.) is little known, but probably will be found to resemble that of Singareni.

The discovery of a good coking coal in this district would solve the problem of smelting the excellent iron ore which occurs in quantity in Madras.

Madras.—The Presidency is not officially recognised as a coal producer. Very little true coal is likely to be discovered here. As the occurrence of good coal in this area would be of the highest importance, especially in connection with the smelting of the excellent iron ores of the Salem district, borings for the mineral have constantly been made, but with very unsatisfactory results. Having regard to the importance of the Madras Presidency, and especially to its mineral wealth, this district should be brought into railway communication with the coalfields of the Central Provinces and Bengal.

The Rajahzampolli mines in the Godavari Valley, near Rajahmundry, belonging to the Godavari Coal Company, are said to show an increasing output. No samples have been received for examination. The mines are stated to be not yet fully established.

Beddadonal is probably the most southern place in which coal is found in India. The coal is stated to be of very inferior quality, but the products of this and of the whole of the Madavaram field deserve fuller examination.

Rajputana.—There is one mine worked in Rajputana, namely at Palana, in the Bikanir region. The output in 1900 was 9,250 tons. Little is known of the quality of this coal, which appears to be of the nature of lignite.

Baluchistan.—In 1900, nine collieries were at work, producing 23,281 tons. Thin seams of tertiary coal occur in several places in this province, as in the neighbourhood of Quetta. Coal is worked at Khost, and at Mach, in the Bolan Pass.

The Khost colliery is working seams from 6 inches to 2½ feet thick on the side of the hill. The coal, which is easily mined, is conveyed by a branch line of the North-Western Railway. Khost coal is a bituminous coking coal of fair quality, but contains a large proportion of sulphur. Its calorific value is high. The Khost coal is apt to disintegrate in mining, and the dust is made into patent fuel.

Closely resembling it, is the coal from the neighbouring Killa-Hakim seam, which is nearly free from sulphur.

The output from Mach is small. The coal resembles that of Khost.

Punjab.—In 1900 two collieries were at work, producing 74,083 tons. Tertiary or perhaps cretaceous coal occurs in several localities in the Salt Range, but usually in small quantity in thin seams.

The Dandot collieries in the Jhilan district, 2,000 feet above the sea-level, owned by the North-Western Railway Company, work a seam between 2 and 3 feet thick, which is mined at a number of places in the roughest manner, instead of from one shaft from the centre. The coal is used by the North-Western Railway. The samples sent for examination were of inferior quality, containing less than 40 per cent. of fixed carbon, but showed a fairly high calorific value (see Appendix, Table V.).

The Bhaganwala field, at the extreme east of the Salt range is estimated to furnish about 1,000,000 tons of coal. The sample examined was of poor quality, but showed a tendency to coke. The coal from Pidh and Shahrig in this province is of inferior quality, but may be useful for some purposes, as its heating power, dependent on the presence of solid hydrocarbons, is greater than was to be supposed. It might be expected to furnish oil or gas, on distillation, but the samples sent did not give satisfactory results. All these coals possess the disadvantage of containing a relatively high percentage of sulphur.

Kashmir. — Coal is known to occur in several localities, especially in the Sangar Marg hill. The seam appears to be only from 2 to 3 feet thick, and might, therefore, be comparatively expensive to work.

Assam.—In 1900 six mines were at work producing 216,736 tons.

The coal of Assam is, as a rule, either cretaceous or tertiary, the latter occurring in seams of great thickness, chiefly in Upper Assam. The tertiary coal is the more important; cretaceous coal, as a rule, being somewhat woody and resinous, burning quickly.

Cretaceous fields are those (Daranggiri, &c.) of the Garo, Khasi, and Jaintia Hills. In working these mines tunnels are made horizontally into the sides of the hills. Tertiary coal is similarly worked at Makum and at Cherrapunji.

The Makum mines, in the district of Lakimpur, which are the most important as coal producers, contain very thick seams, some between 75 and 100 feet thick, and are estimated to contain about 18,000,000 tons of coal. These mines are near the terminus of the Assam-Bengal Railway and are likely to show a considerably increased output in the future. The coal furnishes little ash and gives out more heat than most Bengal coal. It is regarded as one of the best steam coals in India. It is evident, however, that it varies much in quality (see Appendix, Table V.). Certain samples formed coke. Further information is desirable as to a seam near Tikak, from which an excellent sample was taken.

The Cherrapunji field is situated on a ridge of the Khasia Hills. It is distributed over an area of less than a square mile, and is estimated to contain about 1,000,000 tons. The sample examined, though it formed a good coke, and showed considerable calorific power, was inferior to that previously analysed, which was of first rate quality (see Appendix, Table VI.). More information is desirable as to the average quality of this coal and of that contained in other fields of this district, especially of Lakadong in the Jaintia Hills, where similar coal is being worked on a small scale. In the Saffrai (Nazira) and other districts of the Naga Hills, hard durable coal has been found, of which we have little knowledge at present. Since good iron ore and limestone are said to occur in Assam, the question of the average quality of the coal is of much interest, and should be further examined.

Burma.—In 1900 only one colliery was in active working, producing 10,228 tons.

The coal of Burma is chiefly cretaceous. Though not of the highest quality, there can be no doubt that some of it makes serviceable fuel.

The chief fields are those of Thingadaw in the Shwebo district, including the Letkokbin mine on the west bank of the Irrawaddy, about 60 miles from Mandalay. The seams are from 4 to 5 feet thick. The coal is compact and hard, resembling the cretaceous coal of Upper Assam. No satisfactory sample was submitted for analysis.

The Chindwin fields near Kaliwa on the Chindwin River, contain good cretaceous coal in seams from 1 to 12 feet thick. The ash of all the Burma coal is small.

Reference may be made to the coal occurring in the Northern Shan States and on the Great Tennasserim River, as deserving of further investigation.

I have now given a brief and necessarily general account of the Indian coal deposits. For further information as to the precise character of the seams, &c., recourse must be had to the memoirs and records of the Geological Survey of India, to which we are almost exclusively indebted for our precise knowledge of the localities where coal exists. The latest information is, however, scattered and inaccessible, and requires to be brought together in a single volume. This is the more necessary as Ball's "Economic Geology of India" is now much out of date.

Quality of Indian Coal.

The numerous analytical results given in the Tables V., VI., and VII. appended to this paper show that excellent steam and coking coal occur in India, especially in Bengal and Assam. These Tables include all the principal analyses which have been recorded. Indian coal, as a rule, affords more ash than the best European coal, and its calorific power is usually somewhat lower. Taking all the defects of Indian coal of average quality into account, it may be said to be from 17 to 20 per cent. inferior to average British coal of the same type. The chief types of Indian coal which were analysed are compared with average British coals in the accompanying tables (see Appendix, Table VIII.)

The fact that the seams furnish coal which varies greatly in quality, even in one and the same seam, is evident from the comparison of the results of examination of different samples (see Appendix, Tables V., VI., VII.). My own results in certain cases show considerable variation from those of previous observers, chiefly of the Indian Geological Survey. From information I have received from users of Indian coal, it is apparent that this aspect of the matter is one which should receive much more attention from the colliery companies and their agents. Complaints are not uncommon as to the disappointing results which have been obtained from the trial of Indian coal reputed to be of good quality.

I was glad to see that Mr. H. H. Macleod, in a speech delivered at the last meeting of the Indian Mining Association, drew attention to the subject and remarked:—

"Our only serious rival—English coal apart—is Japan, although at some time or other we may have to contend with the limitless deposits of China. But that is in the future, and the mere fact of such a contingency should make us all the more energetic at present. What we have now to do is to strive to displace Japanese coal in those Eastern markets, where it is ahead of us. Singapore, for instance, is a port where we ought to do a very great deal better than we have done hitherto. I notice that the imports of Japanese coal into Singapore for the years 1898-1899 were 263,051 and 280,665 tons, respectively, as against 80,090 and 73,695 tons, respectively, of Bengal coal, while the average price was 15 dols. 20 cents., and 10 dols. 35 cents per ton for Japanese, 10 dols. 18 cents and 9 dols. 70 cents per ton for Bengal. We know that cheap freight is the rule rather than the exception from Japanese ports to the Straits, as it is to Bombay; and we would, therefore, naturally expect to see a close approximation between the prices of Japanese and Bengal coals at a Straits port like Singapore. Such, however, is not the case, and it is interesting to inquire why Japanese coal should realise one to five dollars per ton more than our article. There is no parallel for such a difference either in Colombo or Bombay; and the only possible explanation is that the Bengal coal sent to Singapore has been inferior in quality to that sent from Japan. And here it seems to me that we come to what may be, unless we are watchful, the greatest stumbling block to the development of our foreign trade. This question of quality cannot be too strongly insisted upon. And when we hear of a cargo of Bengal coal reaching its port of destination only to be condemned, and of trials made at another port giving unfavourable results, we have before us object-lessons which afford food for very serious reflection. In my opinion nothing can be so damaging to our future prospects as the shipment of indiscriminate qualities. It is a direct menace to the future of the trade, and will do more than anything else to handicap us in those markets where we have to compete with foreign coal. As for our other great rival—English coal—we know that prices are falling, and we expect them to fall still further. Consequently, with low outward freights, Bengal coal may be, so to speak, squeezed out to a certain extent. But I think to a certain extent only, because the case of Bombay shows that our best qualities have held their own even with English prices at their lowest level. And if that has been our experience at Bombay, there is no reason why it should not be so elsewhere. I have said our best qualities, because the question of quality is, if anything, even more important in our competition with English coal than it is when we are struggling against Japanese. Hitherto we have blamed, and I must say, to a large extent rightly blamed, the railways and the Port Commissioners for the slow progress of our foreign trade. But if when our coal actually gets into foreign markets, it is rejected because of its inferior quality, or for the same reason is sold at unprofitable prices, the onus of our failure will rest upon ourselves. Our railway and dock difficulties will be surmounted in time. It may be a long time, but whether it be long or short, let us at any rate take care to do nothing in the interval to damage our ultimate chances in foreign markets, by offering coal which is useless to them and discreditable to us."

Many of the questions which are raised in the development of the coal industry in India require the advice of an expert for their determination, and I venture to suggest that the Government of India, through the Geological Survey, might render important service to the development and extension of this industry. Economic geology should occupy an important position in a country like India, where industrial enterprise is one of the most pressing needs. Much still remains to be done in exploring many of the Indian coalfields, and in ascertaining precisely the quality of the coal they furnish, and the purposes for which it is adapted. In all these respects the department of the Geological Survey, if so requested by Government, might render considerable assistance if it were understood to be the principal duty of several of its highly qualified officers to make all the necessary investigations of the Indian coalfields, from an economic as well as from a scientific standpoint, and to supply information of industrial value on the many questions involved in their successful working. There can be little doubt, that some of the coal seams have suffered considerably from having been improperly worked in the first instance without technical advice.

From the results of the most recent examinations of samples of Indian coal, I am led to conclude that coal of better quality is being mined from certain seams than was formerly the case.

It should not be forgotten that cheapness is the factor which chiefly determines the present increasing output of Indian coal, and for this reason Indian coal of poorer quality is taken by steamships in preference to the better English coal on account of its much smaller cost.

It is desirable that exact information should be obtained as to the extent to which the different varieties of Indian coal are likely to undergo deterioration during transport and storage, so that the necessary precautions maybe taken. It is certain that some Indian coal will give trouble on account of the readiness with which it fractures. Other varieties are liable to the disintegration which is the result of atmospheric weathering. I allude elsewhere to the means by which the "slack" and broken coal could be utilized.

Since Indian coal is now largely consumed by steamship companies plying in Indian waters, I have enquired of the principal steamship companies trading with India, to what extent they consume Indian coal, and what their experience is of its use. I summarise the replies I have received from the chief steamship companies:—

1. "I am desired to inform you, that all the Company's Indian coal purchases are made at Calcutta, and that, although the qualities of the various descriptions obtainable there differ considerably, our general experience may be set down to indicate that the consumption is 25 per cent. above that of Welsh coal.

"I may add, that in our mail steamers, we have never been able to obtain a satisfactory result in point of speed, from the sole employment of Indian coal; to affect this, a mixture with Welsh coal in the proportion of, say one-third of the former, to two-thirds of the latter is necessary."

2. "All the coal we have purchased east of the Suez Canal, during this year (1901) has been Indian coal, with the exception of the small quantity we required for a vessel under our charter, which vessel not being provided with forced draught was unable to make satisfactory use of Indian coal.

"We may say generally that our experience is that the Indian coal has improved in quality, and we consider it likely to hold its own in the supply of the Eastern market."

3. "We are large users of Indian coal. It is difficult to give you any definite information as to the practical value of Indian coal, that is steam coal, such as we use for our steamers, owing to the widely fluctuating results in consumption as they appear to us from experience. We have tried the various qualities of coal supplied at Calcutta, in some cases buying these coals through the London agents of the suppliers, or in other cases buying them through our agents in Calcutta; but in all cases our enquiries have been made for, and our object has been, to purchase the best description of coal for steamer purposes.

"We have been most disappointed in results, as a general experience; and we think we are not far wrong if we state that we have found the general character of Indian coal far worse in practical value than any other coals which we are accustomed to deal with. At the same time the exigencies of our trade compel us to have recourse to Indian coals even in the face of such drawbacks.

"We are being impressed by degrees that a better description of coal is being produced in certain parts of India than any which we have been accustomed to have supplied to us at Calcutta.

"We consider that the coal business of India could be immensely developed by means of supplies to steamers if only shipowners could be made acquainted, on unquestionable authority, with the names of the best descriptions of coal suited for the purpose. We consider, upon such imperfect knowledge as we possess of the circumstances affecting the coals shipped in Calcutta, that the coal proprietors do not give proper or efficient supervision in raising the coal and sending it for shipment to ensure that it has been cleaned of the enormous percentage of dirt which apparently is raised with it.

"We have found some of the coal capable of fairly raising steam, but it has been sadly depreciated by the large amount of dirt which is mixed with the coal. We are sure this could be obviated to a large extent in the same way as is now done in this country if only proper machinery were made use of for cleaning the coal.

"There is a great opening for the Government to assist in the development in the coal resources of India by establishing some system which shall ensure the coal being sent to port in a much cleaner condition, and which shall prevent the large percentage of dirt and rubbish which now goes under the name of coal. Also, as Government control the railways, they might bring about some improvement by a better supply of railway trucks.

"Our steamers use coal from various countries. We buy largely of British coal (Welsh, North Country and Scotch), also we are large users of Natal coal and of Australian coal, as well as of coals raised in the United States and shipped at the Atlantic ports, New York, &c. Our reason for purchasing these various descriptions is that it is convenient for the trades in which our steamers are engaged, but as your enquiry appears to be more particularly as to the Indian coals we may state that we often give a decided preference to one or other of these coals (which can be obtained in India) over the Indian coals even at a very large increase in price. If some means could be taken to improve the quality of the Indian coals obtainable at Calcutta and other Indian ports, we have no doubt we should be able to reduce our use of other coals, and thus take a larger share of our requirements in Indian coals, and in this way we have no doubt the development of the coal resources of India would be accelerated."

4. "The Assam coal is good, but, with two or three exceptions, we have found Bengal coal not at all suitable for our steamers. At the same time we use it freely on board our vessels, as the cost of it is small compared with the price of imported fuel."

5. "This company have been using Indian coal as steam coal for the past five years or so; and in spite of repeated trials with different qualities, they have come to the conclusion that Indian coal does not answer the purpose for fast-going steamers, as it does not give the required pressure for a certain speed which British coal generally gives, the consumption being at an average of 40 per cent. higher.

"For this reason, which is capital, it is likely that the company, and no doubt all others entrusted with mail contracts, will not extend the employment of Indian coal as long as British coal is procurable with advantage.

"Indian coal will still and always be of great advantage to cargo-boats and tramps for which speed is a matter of no importance."

6. ". . . We have been supplying only Indian coal here (Bombay) to our steamers since the great rise of prices in Cardiff two years ago.

"Our engineers have found that the 'Desherghur' from Bengal gives the best results. I may add that the Indian coal is generally considered to be about 10 to 15 per cent. less effective than Cardiff, the evaporation being quicker.

"Our present price for 'Desherghur' is 20s. per ton, while Cardiff could not be had under 28s."

7. "Indian coal is used exclusively in the Company's steamers trading east of Suez, as it is cheaper than British coal; the company's steamers trading between Europe and the East use English coal only west of Suez, where, as yet, Indian coal cannot compete with English coal."

8. ". . . . We have only carried Bengal coal once for use in our steamers, and the result was so bad that we never tried it again. We are sorry we are unable to give you the name of the mine whence it came or any particulars, other than that it was taken in at Rangoon and consumed between that port and Colombo."

9. "The facilities for transport and distribution are greatly hampered, as the supply of railway rolling stock does not meet the requirements of the trade. We are also of the opinion that if the railway rates were reduced, the distribution to more distant places would be the result. We consider the Government should assist the development of the coal resources of India by arranging for greater railway facilities. This is a matter which has frequently been brought to the notice of the Government of India in recent years.

"In our steamers and factories we consume about 5,000 tons of Indian coal per month, and we find it a fair steaming coal; but to get the same results out of a boiler as you would with Welsh coal, it is necessary to have about 15 per cent. more grate surface. We only employ British coal on this side of the Suez Canal."

10. "The number of steamers in our company (including launches) is 86, and the coal consumed during the year 1900 amounted to about 1,050,000 tons, the whole of which was raised in India.

"We may state that with a good quality of Indian coal we have no difficulty in maintaining steam in any of our vessels, and, so far as we can trace, we have never used any other than Indian coal since the formation of our company nearly 60 years ago. For very many years our supplies were drawn exclusively from the coalfields on the Burdwan and Raniganj districts in Bengal, and we still draw the bulk of our Calcutta requirements from that region. In 1885, coal from the Lakimpur district, in Assam, became available, and since that date our requirements for the Brahmaputra line have been drawn from that district, Dibrugarh being the port of shipment. This Assam coal is superior in steam raising power to the Bengal product, and is used as much as possible, but the cost of carriage prohibits its use in Bengal. We are, therefore, in the advantageous position of being able to draw coal supplies at both extremes of our principal (*i.e.*, Assam) line."

As Ceylon is becoming a large user of Indian coal, the following statements as to experience of its use there are of interest:—

"The Indian coal imported into Ceylon is drawn from Bengal, and the quantities imported since 1894, have been as follows:—

	Tons.
1894	61,586
1895	47,566
1896	67,417
1897	105,213
1898	213,852
1899	163 908
1900	335,346
1901 (For 9 months, Jan. 1 to Sept. 30)	260,869

"From this it appears that the offtake is increasing rapidly, the greater part being for the supply of steamers calling at Colombo; but about 40,000 tons a year are now being consumed on the Ceylon Government Railway.

"The objections to Indian coal as compared to Welsh coal are, that the former leaves more ash, and consequently about 25 per cent. more is required to accomplish the same amount of evaporative work.

"The chemical analyses of some well-known Indian (Bengal) coal is as follows:—

	Per Cent.
Carbon fixed	65·75
Volatile matter	26·05
Ash	6·55
Moisture	1·65
	100·00

"Steamers are finding it so much cheaper than Welsh coal that it is being more largely used every year, and there is every likelihood of it coming into general use for all but mail steamers, which require Welsh coal on account of the speed required to be maintained. Indian coal is used by industrial establishments in Colombo, such as ice factories, the electric car generating depot, &c., but the quantity thus consumed is not large. A few years ago, owing to the absence of sufficient facilities for transport on the Indian railways, the conveyance of coal to Calcutta was much hindered, but this has, in some degree, been remedied.

"The consumption of Indian coal by steamers is likely to expand rapidly, for, as new steamers are built, provision is made for draught in the furnaces such as will admit of its being used more generally; and, in a measure, this will tend to the displacement of Welsh coal."

The following remarks are taken from the reports of locomotive engineers of the Ceylon Railways, which have recently largely used Indian coal:—

"In 1897 the increased expenditure was chiefly brought about by the cost of Welsh coal having jumped from an average of Rs. 18-50 per ton in 1896 to Rs. 27-62 in 1897. This tremendous increase in the price of British coal would have had a still more serious effect upon the working had it not enabled Indian coal to compete successfully with it, and during the year 8,081 tons of Indian coal were consumed at an average cost of Rs. 13.09 per ton. Indian coal, under the most favourable conditions, shows an inferiority to the best Cardiff coal of 17 per cent. on the low country main line, and on the upper main line sections, on the grades of 1 in 44, from 30 to 33 per cent. inferior. The use of this coal on these grades gave considerable trouble, as the large consumption per mile on the up journey, namely, 140 lb. per mile, left so much residue in the fireboxes after a 20-mile run that it was absolutely necessary to clean the fires to such an extent that time was invariably lost.

"The altered grate arrangements also permitted considerable quantities of burning coal to drop into the ash pans and from them on to the sleepers, which gave rise to several complaints from the permanent way staff. The coals burned were Borrea, Anthracite, Giridih, and Singareni, the most economical and suitable being Giridih; but the continued use, even on the lower sections, will to a great extent be governed by its relative cost compared to Welsh coal. At the price paid for it during the year it is very close competition with firewood.

"A saving of Rs. 113,000 was effected in the running charges by the use of Indian coal during 1898. The general adoption of Indian coal instead of Welsh coal has very considerably reduced our locomotive expenses; so much so in fact that the consumption for the year shows an increase of 3-800 lb. per train mile, yet in consequence of the cost of Indian coal (including handling) having been less by 10 per cent. per train mile, the result has been a saving of Rs. 113,000.

"In 1898 fuel consumption increased to 99 lb. per English mile and 5·30 per train mile. This increase was due to the large use of Borrea coal, which gave considerable trouble throughout the year."

The employment of Indian coal on the Indian railways is largely increasing. (See Appendix, Table IV.)

On the whole, the information as to the value of Indian coal for steamship and locomotive purposes obtained from the principal consumers is fairly satisfactory and encouraging. It is evident, however, as I have already pointed out, that better supervision must be exercised in order to secure for these purposes the most suitable coal, and greater care taken that it does not for any reason fall below standard quality. It would probably be worth while for the colliery companies to appoint a special inspector in Calcutta for this purpose.

METHODS OF MINING, LABOUR, PRICES.

In 1900 there were 271 collieries working in India, producing more than 6,000,000 tons of coal, valued at over 20,000,000 rupees.

Native labour is universally employed and the coal is generally cut by hand. In 1900 nearly 90,000 people were employed in coal-mining, the average pay for underground work being about $1\frac{1}{4}$ rupees a week. Modern machinery for haulage is being gradually introduced into the Bengal mines, and the "gin" and bucket worked by women is less commonly seen.

The mines are owned partly by joint stock companies, private individuals, and the State, generally through the railway companies.

Indian coal at the pit's mouth is probably lower in price than in any other country, often reaching 2 rupees a ton. The local wholesale selling price of Bengal coal was, in 1900, 4s. 5d. a ton, as against 4s. 2d. in the previous year. The wholesale price for imported coal in Calcutta averaged 32s. 1d. per ton. The export duty on British coal will no doubt tend still further to stimulate the coal industry of India, and to reduce still further the imports of British coal into India.

The following accounts of the mode of working in the mines (taken chiefly from the "Imperial Institute Handbook," 1893) will be of interest.

In the Bengal fields the Bengal Coal Company reported that—

"The labour is always causing trouble. There are far too few miners, and there is far too much independence. The average miner never attempts to earn more than a day's wage, although the people might work themselves up into a position of comparative comfort if they would try to. The bulk of the labour consists of Bauris and Sonthals.

"Karharbari coalfield is mainly worked by three companies—the Raniganj Coal Association, the Bengal Coal Company, and the East Indian Railway. The system here is similar to that obtaining all over Bengal. The working hours are from 6 a.m. to 6 p.m., and, perhaps, later when extra work is required. Only four days a week real work is done, and the consequence is that collieries must have a far greater number of working places than the same output in England would warrant. All the miner's family work with him, carrying or training his coal. Picks of English pattern and make are now universal, the crowbar and single pick having been ousted. The workings are on the bord and pillar system. Pillars vary from 12 feet to 40 feet square and 40 feet × 60 feet. In the shallow mines and thin seams (7 to 8 feet) the former size obtains; in the thick seams (from 12 to 20 feet) the latter. Pillars are worked in the 8-feet seam in the following manner: A 4-feet chock is placed between each pillar in the row of pillars (generally six in number) that are to come out. A chock is also placed in front of each pillar. The pillar is then attacked from the front side. When pillars are taken out, the chocks are withdrawn and the roof falls.

"The remarks on the Raniganj coalfield given below apply in some measure to the Karharbari field. On sinking, coal cutting, the miner's love of holiday, lighting of mines, &c., the description in one case is a description in the other. Payments in this coalfield are weekly on Sunday mornings, the miners resorting from the pay offices to the East Indian Railway bazaar, which was established to attract local labour, and which has done so. The labourers consist of low caste Mussulmans and Hindus, as also aborigines—Sonthals and Kols. There are some Bauris, brought from Raniganj to teach the local men how to cut coal. The local men, however, cut coal better, as they have discarded the Bauri *sabel*. Local labour is more tractable, and the Bauris are not in such requisition as formerly.

"Drainage is effectively carried out by Tangye's special and lifting and forcing pumps, worked by bob-levers from horizontal engines. The machinery is of good type, and winding and hauling are done by good engines.

"Ventilation is attended to in the deep mines, mainly by furnaces or steam-jets.

"The miners live in small villages, aggregations of huts of mud walls of bricks set in mud with thatched or tiled roof. The hut consists of one room, sometimes two, of from 6′ × 6′ to 10′ × 10′ in size. Those better off have cowsheds and granaries; these two latter with the dwelling forming three sides of a quadrangle. The larger proportion of the labourers cultivate during the rainy season, and work at the collieries only in the cold season, say, from October to June. Some of the labourers have settled down to coal-cutting as a calling, and these work constantly, always excepting Monday, which is invariably a holiday.

"Coal-cutting is paid for by contract at so much a tram or bucket. These are of various sizes. The price generally amounts to from 7 to 8 annas per ton for large, and $1\frac{1}{2}$ to $1\frac{3}{4}$ annas per ton for small coal. All other work, as stone-cutting, sinking, rail-laying, &c., is paid for by daily wages.

"The coal is hand-picked into four kinds. Steam is larger than 2-inch cube, rubble larger than $\frac{3}{4}$-inch cube, smithy down to $\frac{1}{4}$-inch cube, and all smaller than that is called slack or dust. This picking or screening is done by contract, and for rubble and smithy the coolies get about 4 annas per ton. Slack is not paid for. Loading is done by hand into the railway wagons. At the mines tipplers are used for discharging the coal from underground trams into the wagons that run into the narrow-gauge tramways."

"In a paper read before the North of England Institute of Mining and Mechanical Engineers, in 1880, Dr. Saise said with reference to mining labour at the Karharbari coalfield:—'The men are not perfectly weaned from their ordinary caste pursuits. The hold on them is not great, and any discontent is followed by migration. They pick up their beds, or rather the wives do, collect the cooking utensils, gird up their loins, and depart. Labour has been attracted to settle in the immediate vicinity by allotment of land at nominal rents on the understanding that, when cultivation is over, they shall work in the mines. The rainy season no sooner commences than the labour decreases. Men, women, and children go away to cultivate their own plots, or the plots of those to whom they are indebted, and the output drops. From the beginning of July until November the cultivation, and then the religious festivals, keep the output low. From November to June following most of the coal is raised. Cheap rice makes labour scarce, as a native will not work if he has enough to eat without it. Scarcity fills the mines to overflowing. Still the general state is "want of labour." It will probably take many years to train up a set of miners who will follow nothing else but mining as a profession."

"The following notes on the Raniganj coalfield are by Mr. T. H. Ward:—

'The Chord line of the East Indian Railway passes across this coalfield, and the collieries are clustered on either side and along the Barákar branch sidings and branches, up to six miles in length, built by private enterprise, connect most of the collieries to the main line. Here winding engines, wire-rope guides and tipplers, and the regular paraphernalia of an English colliery are fast supplanting the primitive "gin" and bucket of a few years ago. These gins were (and some are still) turned by women, 25 to 30 being employed on each gin. They kept time to a monotonous chant, which they sang as they tramped round and round.

'The sinking in the district is easy, through soft sandstones, no brickwork being required to protect the sides. Heavy water is sometimes met with.

'The coal in the east of the field is very strong and non-caking. The sandstone roof is also very strong, and comes right down into the coal. Practically no timber is required in working the coal in the manner described below. In the west of the field at Sanctoria, for instance, the coal is not so strong, though the roof is everywhere the same. From Belrooi near Sitarampore, westwards, the seams worked are all coking coals.

'The seams worked are seldom less than 10 feet, and sometimes reach 18 feet in thickness. In the Barákar Coal Company's Kumardhubi colliery and the Bengal Coal Company's Laikdee colliery on the west of the Barákar, the enormous thickness of upwards of 80 feet has been found.

'The mine is laid out underground on the same plan throughout the district. This plan has been stereotyped all over the field, and is adopted without reference to its suitability to the different conditions obtaining in the various seams worked. Indeed it has been adopted apparently more with reference to the prejudices of the native miner than from economical considerations. Galleries are excavated to the full height of the seam, 12 feet to 16 feet in width, leaving square pillars of varying sizes to support the roof, many acres being thus often left on pillars. The native coolie insists (and he has his own way very much in this coalfield) on commencing operations at the roof, and working downwards until the full height of the seam has been excavated. His chief and dearly-prized weapon is a 'sabal' or crowbar, with a sharp point at one end. With this he smashes the coal, standing always when at work. He never groves beyond the first "cleat." Gangs of four to five men occupy each gallery. They are paid by the bucket or tram of steam coal or small delivered at the pit bottom. If any timber has to be set up in a working place, a man of the carpenter class (Chútar), who is paid a daily wage, must be sent for the purpose.

'Women and children work underground, and are principally employed in carrying the small coal and dust. They are also paid by the tram or bucket. The women often take their babies, two and three months old, down the mine, taking with them also a small cot on which the child sleeps or plays while its parents are at work.

'Access to the mines is very generally by inclines opening to the surface.

'In the eastern part of the district the seams are for the most part flat, in the central and western parts the strata are often steep (the general dip being southerly), and intrusions (dykes) of trap rock become more frequent. The deepest shafts are about 250 feet, the largest part of the coal yet won being from much less depths. Some fire damp has been met with in the western part of the district. Chanch colliery (west of the Barákar) belonging to the Bengal Coal Company was abandoned some years ago after an explosion in which several men were burnt, some of whom died. At Sanctoria, also belonging to the Bengal Coal Company, some men were burnt in 1883.

'The quarries at Kumardhubi and Laikdee have already been mentioned. Thousands of tons of coal have been won from the outcrops merely of these magnificent seams, and thousands of tons remain still to be worked without indenting on their resources at any greater depth.

'The "Bauri" is the principal caste which supplies coal-cutters for the district. In some respects the Bauri colliers' characteristics are amusing like those of his Western prototype. He is very fond of getting drunk, especially at week ends, and is very disinclined to go to work on Mondays. For the rest he is good-tempered and improvident. It is a difficult matter to persuade him, although he is always paid a "ticca" (contract) rate for his work and could easily increase his earnings to do more than will, with his wife's contributions, keep the household in rice and himself in drink for the day. The nearly universal and very bad custom in this district is to pay each evening for the work done during the day. The collier or cooly has often to wait about until 8 or 9 for his money. He then goes cheerfully home, and remains up half the night drinking and singing with his companions (he is very social in his habits), incomprehensibly happy with his tuneless tom-tom. In the morning he trudges back, very often 7 or 8 miles (a distance of course travelled twice a day), to work, and is down in the pit at 9 or 10 a.m. All day, in the intervals of work, he sucks the comforting hubble-bubble (hookah).

'The light which the collier carries with him is exceedingly primitive. He gets an allowance of oil in proportion to the number of trams of coal he cuts. Every morning he draws at the godown sufficient for his requirements during the day, and an allowance of cotton thread or old rags to serve for wick. This oil he burns in a "chiragh" or small piece of stone hollowed out into the shape of a boat (a piece of tile from the roof of his house is often substituted). In this he places a small quantity of oil and a portion of wick. Any oil he can save from his allowance is his perquisite, and he can carry it home. Mohawa and castor-oil are the chief oils used. Some of the mines are lighted by kerosine burnt in small tin lamps holding about two ounces, with small circular wicks. The native does not like this plan so well, as he cannot use it to rub on his body or to season his food, a purpose for which mohawa oil is used.

'The ventilation of the underground workings receives very little attention, and in most collieries none at all. The great freedom from fire damp and the lofty seams exploited have kept this question in the background. The ignorant native has not yet recognised that his health and longevity are in question, and he has besides helped much to prevent ventilation becoming a necessity by the wonderful power of endurance he has shown. This power of endurance enables him to work for hours at the bottom of a sinking shaft with water pouring over his naked body, or to work all day long and day after day in driving a "rise" gallery, perhaps hundreds of feet from any current, in an atmosphere which is fœtid and laden with steam. This is a blot on the mining of the district, and ought to be speedily removed."

'At Warora, Central Provinces, where 100,000 tons per annum are wound by direct acting engines out of two shafts 200 feet deep, the system nearly approaches the English. No women work underground, and work is constant from Monday morning to Saturday night. The work time is divided into three shifts of 8 hours each. The seams, which vary from 8 to 12 feet, are worked thus: Galleries or boards and headways are driven 12 feet wide, 6 feet in height, leaving the roof coal and pillars 40 feet square. The coal is so hard that it has to be nicked and undercut, and then blasted down. The pillars are worked by splitting each from one headway to another, and then taking the far end off in slice. The roof coal comes with it.

'The colliery consists of six pits, varying in depth from 100 to 250 feet. All the pits are supplied with sidings, and connected with the Wardha State Railway by a branch line. Only two sorts of coal are vended, large coming over a screen with bars spaced 1 inch apart, and small coal passing through the screen. It is very superficially screened by women. All the coal is got by contract, from the hewing to the final loading into trucks. Three or four contractors are employed, who provide all the labour and oil, but who are provided with all tools, gunpowder, shot and shot-firers.

'The labourers are principally drawn from the North-West Provinces, and are not very plentiful. These men are allowed a *chabootra* within the boundaries of the colliery property, for which they are charged a ground rent of 3 or 4 annas per month. They also have to pay 1 anna a month per head of cattle.

'At Singareni (Hyderabad), the general system of working and the tools used are the same as in England, slight variations being allowed to suit the people. Part of the coal is got by contract, and part by sirkary labour. Underground labour has been organised under a system of eight-hour shifts, surface coolies and machines working ten hours per day. The rates of wages vary from about 5 annas per day for ordinary labour to 12 annas as earned by coal-cutters on piece-work. Machines average above 1 rupee, while superior men earn considerably more.

'Female labour is paid from 3 annas for surface, and 3½ annas for underground work. Local Teluga labour of the lower class is fairly plentiful. The superior work is done by Mohammedans of Hyderabad, or Hindustan men imported.

'At the Mohpani collieries a similar system is worked. The difficulties met with in these mines, owing to the faulted and disturbed nature of strata, are probably unequalled in India.

'Labour was one of the greatest difficulties, and progress was, and is, often impeded on this account.

'However, a great many miners who had been gradually collected, and trained in the mines, live in the immediate district, and a certain amount of labour can be imported from other districts when the demand for railway and harvest works do not interfere.

'Coal hewers work 6 to 8 hours for a shift or day's work, and earn about 6 rupees to 12 rupees per mensem.

'Mechanics, enginemen, &c., work 8 to 10 hours per day, and earn wages from 8 rupees to 20 rupees per mensem according to their craft.

'Coolies, &c., work 8 to 10 hours per day, and earn 5 rupees to 8 rupees per mensem."

A Mines Act regulating the conditions of labour in the Indian mines has recently become law, but its provisions are not viewed altogether with favour by the owners and capitalists. One of its provisions is to require that all mine managers should hold certificates that they possess certain qualifications. This is an excellent stipulation, which no one who has the interests of coal-mining in India at heart could possibly object to on general grounds. It is, however, alleged that no facilities are provided in India by means of a properly established mining school or otherwise to enable men to acquire the necessary qualifications, and the result is that a new burden will be imposed on the industry by reason of men having to be brought from abroad to act as managers at higher wages than would be paid to properly qualified local men. I do not feel competent to say how far these objections may hold, but I am confident that great good would result from the establishment in India of a Government School of Mines and Metallurgy, in which those who intend to engage in mining and metallurgical industries could receive a thoroughly practical and efficient training in modern and scientific methods, not only in engineering and mining, but also in physics and chemistry in their applications to metallurgy.

The introduction of mechanical coal-cutting machinery, which has been already tried in a few of the Bengal mines, is no doubt the true remedy for many of the difficulties which arise from the employment of native labour for cutting by hand. By this means, too, a greater output would be secured, whilst the waste arising from the production of slack would be largely avoided.

Cutting by the compressed air system has the advantage of assisting in the ventilation of the mine, a consideration of importance, but electrically driven cutting machinery is now being adopted in other countries, especially in the United States, where the cost of coal at the pit's mouth has been so reduced in recenty ears that it is now nearly one-half of that in England (10s. 9¾d.), and is not far removed from the average price in India.

Ventilation of the mines is a subject which ought to receive greater attention in the future, whether the native is indifferent to it or not; and where fire-damp occurs, as in some of the Bengal mines, further precautions will have to be observed with reference to the use of naked lights and the lighting of fires. Many of the Indian mines fortunately are nearly free from fire-damp.

TRANSPORT.—RAILWAY AND DOCK COMMUNICATION.

The question of further railway communication with the various coalfields has been alluded to.

It is obvious that the successful extension of the coal industry in India must depend very largely upon the facilities afforded for railway communication with the coalfields and with the docks, and also on the dock arrangements for unloading and shipping.

In the case of a rapidly growing industry, care and discrimination are required in planning railway and dock extensions, so that they will be sufficient to meet growing requirements for many years in advance, and at the same time be readily susceptible of further extension at any time in the future.

The Bengal fields being the most important at present, have naturally taken the first place in the consideration of these questions.

The present dock arrangements at Calcutta are, in the opinion of those connected with the industry, altogether insufficient to meet the present requirements, principally with respect to railway communication and provisions for unloading. I need not fully discuss these questions here, as schemes both for additional railway and dock accommodation and unloading appliances have been now sanctioned by the Government, and will, it is hoped, prove to be satisfactory to those who look forward, in my opinion correctly, to a considerable increase in the output of the Bengal mines in the immediate future.

There is another matter intimately connected with the question of railway accommodation to which I must make some allusion. I refer to the difficulties which have arisen chiefly in Bengal between the railway companies and the colliery companies.

Grave complaints have been made, which have now reached the public press, as to the inadequate traffic arrangements of the East Indian Railway, which itself works collieries in the Bengal fields, and of the damage done to the coal industry by insufficient wagon supply and delays in traffic and high rates of transport.

As this subject is one which must necessarily be of vital importance to the development of the coal industry in Bengal, and belongs to a class of problems in the solution of which Government ought to be able to successfully intervene, I have considered it desirable to obtain the views of the Bengal colliery companies, as represented by the Indian

Mining Association in Calcutta, on the one hand, and of the officials of the East Indian Railway Company, on the other. The following is an extract from a letter, dated December, 1901, addressed to me by the Committee of the Indian Mining Association, in response to my request for information as to any difficulties which, in their opinion, at present hinder the natural growth of the industry:—

"The committee of the Indian Mining Association are of opinion—as, indeed, are all concerned with Indian coal—that the transport and distribution facilities at present provided are distinctly unsatisfactory. The chief defects may be roughly classified under three heads:—(1) a serious and constant deficiency of rolling stock on the principal coal-carrying railway—the East Indian; (2) heavy railway freight charges; and (3) inadequate and inefficient loading facilities in Calcutta—the port of shipment.

"For particulars of the first named of these difficulties the committeee would refer you to the accompanying copy of a memorial which was recently submitted to H.E. the Viceroy by this Association. Further information will be found on pages 86 to 114 of the last annual report of the committee. The facts are fully set forth in these documents; and the views of the Association as to the improvements required are stated in them. It, therefore, only remains for the committee to add that in their opinion it is the urgent duty of the Government of India to adopt such measures as are calculated properly to equip Indian coal-carrying railways with adequate transport facilities. There can be no question that such measures would tend more materially to assist in the development of the coal resources of India than any other action which might be taken by the administration. In this connection it may also be mentioned that the system of weighing in force on the East Indian Railway is defective from the point of view of coalowners. The subject is dealt with at p. 30 of the annual report referred to.

"The second difficulty stated above raises the complicated question of railway rates. In India, such rates cannot fall below or rise above certain minima and maxima rates which have been determined by statute. In the case of coal the maximum rate is 1-3rd of a pie per maund per mile, and the minimum 1-10th of a pie per maund per mile. Even if the Indian coal-carrying lines levied freight on the basis of the minimum rate, their charges would, the committee believe, be in excess of those ruling in other great coal-producing countries such as America. But at present the minimum rate is practically never reached on Indian railways. Freight charges are, in consequence, so high that, in the opinion of the committee, they act as a decided hindrance to the development of the coalfields of India. This difficulty, therefore, like that relating to rolling stock, is one which the Government should in the general interest of Indian commerce do its best to remove. Seeing that all Indian railways are practically owned by the State, the determination of the rates to be charged really rests with the Government, and only nominally with the railway administrations.

"The third point specified above is dealt with in the annual report already mentioned. At pp. 115 to 129 there are a number of papers relating to the proposed institution of mechanical coal-loading appliances at the Calcutta docks. Up to the present time all steamers, whether carrying coal or other cargo, have been loaded entirely by hand labour. Indian unskilled labourers are erratic and whimsical, and the difficulty of providing an adequate labour force whenever it may be needed is, and has always been, of a serious character. Not only, therefore, have Indian coal shippers had to contend against the inevitable slowness of hand-loading, and the loss by breakage which it entails, but they have likewise constantly had to face the possibility of a sudden and complete disorganisation of the labour staff. You will understand from the report that experimental measures having for their ultimate object the termination of this state of affairs are now being put into operation. But, in addition to the provision of adequate mechanical loading appliances, many further improvements in the terminal facilities at the port will be required if the coal trade is to be properly encouraged and developed. For the nature of these I would refer you to pp. 154 to 181 of the report above mentioned, where you will find a reprint of the evidence given in December last by a representative of this Association before a commission of enquiry into the affairs of the Calcutta Port Trust."

Having regard to the statements made in this letter as to the East Indian Railway Company, I have asked the Chairman of that Company, General Sir Richard Strachey, to make any observations with reference to the statements which might seem to him desirable. He has been good enough to send me the following important letter, dated 14th January, 1902:—

"Your letter of the 9th inst. invites me to offer my criticisms on a letter of the Indian Mining Association, of which you send me a copy. This letter, written in reply to enquiries made by you as to the efficiency of the facilities now provided for the transport and distribution of coal in India, supplies, in some detail, a statement of the reasons of the Association for considering those facilities to be distinctly unsatisfactory. This opinion manifestly only applies to the collieries in Bengal, of which alone this Association is in a position to speak with any authority, though no doubt they are by far the most important. The defects that, in the opinion of the Association, now exist are classed under three heads:—

"(1). A serious and constant deficiency of rolling stock on the principal coal-carrying railway—the East Indian. (2). Heavy railway freight charges. (3). Inadequate and inefficient loading facilities in Calcutta—the port of shipment.

"As to the first cause of complaint, it has no doubt to some extent been justified. But the deficiency of rolling stock, so far as it has from time to time really existed, has been due to the material difficulties of the railway in obtaining the wagons that were required; difficulties arising partly from the delay that unavoidably takes place in the construction of the wagons, the materials for which have to be obtained in England, but largely from the delay of the Government in giving their sanction to the expenditure that would be involved, and providing the necessary funds of meeting the expenditure, in both of which respects the East Indian Railway Company is wholly dependent on the action of the Government.

"In illustration of this, I may state that the Directors of this Company, having been informed in May last by the head of the chief coal exporting firm in Calcutta that they were suffering from the want of an adequate supply of wagons, immediately instructed the Company's agent in Calcutta to apply for sanction for the provision of 1,000 more wagons. To this application no reply whatever has even yet been given, after an interval of eight months, though the Board have reported the circumstances to the Secretary of State. Much the same state of things has existed for the last three or four years.

"The pressure that has been put on the carrying powers of the East Indian Railway by the rapid expansion of the coal traffic will be better appreciated from the following figures, showing the whole weight of coal dealt with year by year since 1895:—

	Tons.
1895	2,926,330
1896	3,279,379
1897	3,751,591
1898	4,210,956
1899	4,411,851
1900	5,182,801
1901 (first half of)	2,874,697

"This shows that at present the traffic in the half-year is hardly less than that of the whole year six years ago.

"During this interval the wagon stock, exclusive of brake-vans and other vehicles for special purposes, has been increased from 9,468 to 14,759, with a corresponding addition to the locomotive stock. This, moreover, has been accompanied by a steady increase in the power of the engines and the capacity of the wagons, which have thus become more effective by something like 50 per cent.

"With a business, like the goods traffic of a railway, that is of a fluctuating character, and in which there will be times of great pressure and corresponding slackness, it would evidently not be possible to meet sudden exceptional demands without having a wagon stock greatly in excess of the ordinary requirements of the traffic, and there will, therefore, be unavoidable difficulty in adjusting the supply so as to meet all demands without incurring a wasteful outlay. No doubt a proper margin in excess of the average should be maintained, but with a rapidly expanding traffic, such as that indicated by the figures given, this is not easily determined, more particularly under the conditions above referred to, to which the management of the railway is subject. I do not believe that there is any railway in the world on which, from causes such as this, its customers do not, at some time or other, make complaints of the unsatisfactory manner in which their requirements are met.

"As to the system of weighing, I am aware that questions have arisen, and differences of opinion are held, but this is a matter that obviously must be left to be settled locally.

"I am, of course, not surprised at the opinion expressed as to the coal rates being excessive. But I have not any doubt that they are in fact extremely low, the average charge per ton-mile being rather less than 1-10ths of a penny, which is about 1-3rd of the ordinary English rate according to the *Statist*. I am far from saying that it might not be possible to make some further concession to the colliery owners, by equalising the rates so as to make them somewhat less sharply dependent on the mileage, the necessary charges for transport in the case of a traffic of this sort not being so immediately determined by the distance carried, as in some others. But this is a point on which I am not at present prepared to say more than that it has been under the consideration of the Board for some time past.

"It is quite erroneous to say that the coal rates are fixed by statute. The rates per maund per mile on the East Indian Railway are between 1-10th and 1½-10ths of a pie, the maximum, therefore, being less than that stated by the Association. The average rate on the East Indian Railway for the last half-year was ·13 of a pie per maund per mile, which is equal to 3·52 pies per ton mile, there being 27 maunds to the ton, and 1 pie being the 12th part of an anna, which again, at the present rate of exchange, is just equivalent to one penny.

"From a report drawn up in July last by an officer of the railway branch of the Indian Public Works Department, who visited the United States with the special object of inquiring into American methods of railway management, it appears that there are few instances of rates lower than those on the East Indian Railway, to be found in a long list of American lines, but the average appears to be slightly in favour of the East Indian Railway. Without a more complete knowledge of the circumstances of the separate lines it is not easy, however, to arrive at any very conclusive judgment on this point, involving as it does adjustments on account of differences in the system of weights and currencies of the two countries.

"How the Association, in the face of the great expansion of the trade during the last few years, shown by the figures that have been already given, can venture to say that these rates act as a decided hindrance to the development of the coalfields of India, is truly astonishing, and the more so, considering that the market value of the shares of the colliery companies, is what was pointed out by me at the last half-yearly meeting of this Company. I now repeat the figures I then gave—

	Paid up. Rs.	Quotation. Rs.
Adjai	100	250-255
Bengal	1,000	3,150
Bengal-Nagpur	10	30¾
Borrea	100	155
Barrakar	100	125
Equitable	100	262
Katras Jheria	10	40½
New Beerbhoom	100	179
Reliance	100	190

"The observations of the Association to the effect that whatever difficulty there may be in the matter of the coal rates, or the supply of rolling stock, really rests with the Government, and only nominally with the railway administration, are perfectly true, and it is not the latter that stands in the way of the removal of such difficulties, so far as they exist.

"The next point referred to in the Association's letter is the dealing with the shipment of coal for export to Calcutta. With this the railway company has not been permitted to concern itself, but there can I think be little doubt that it is at present, as described by the Association, inadequate and inefficient.

"The development of the coal industry of Bengal has always been held to be an object of primary importance by the Board of the East Indian Railway Company, and, as I have had occasion to say elsewhere, it is largely to the efforts of this company that the coal trade is in its present flourishing condition.

I am glad to learn that all these questions are engaging the serious attention of the Government of India, and that there is reason to hope that more than one of the difficulties referred to may be removed.

UTILISATION OF WASTE COAL.—MANUFACTURE OF POWER GAS.

The disintegration of coal to which several Indian varieties are peculiarly liable involves a serious waste, and presents a problem which so far has not been solved. Some of this friable coal and slack has been utilised in the manufacture of briquettes and patent fuel, a plan which might be more widely followed. Another much more important purpose to which small coal could probably be put in the future is in manufacturing the particular form of "producer or water gas," known as Mond gas, for the manufacture of which a company with large capital has recently obtained Parliamentary powers to supply certain districts in the midland counties of England with the gas as a source of power for heating purposes. It is stated that the gas is to be sold at about 2d. per 1,000 feet. It is obvious that the supply of cheap gas to the large towns of India would considerably promote industrial enterprise in India, whilst at the same time an important use would be found for small coal, waste, dust, and the inferior varieties of Indian coal which are at present unutilised.

The bituminous character of much of the Indian coal would seem to render it particularly suitable for the production of heating gas. Experiments recently made with Raniganj coal have proved that this is the case. Essentially the process consists in acting on the heated "slack" with a superheated mixture of air and steam, whereby a gas is produced containing hydrogen (about 25-30 per cent.) and carbon monoxide (about 10-15 per cent.) and a smaller proportion of marsh gas, together with nitrogen and carbon dioxide. Sulphate of ammonia may be recovered as a by-product. A ton of ordinary slack furnishes about 140,000 cubic feet of gas, and yields on the large scale 90 lbs. of sulphate of ammonia. The calorific value of the gas is stated to be about 84 per cent. of that of the slack used. The gas may be used successfully for nearly all industrial heating purposes, for the manufacture of bricks, earthenware, glass and pottery, in the production of steel by the open hearth process, and in forging, welding, and annealing iron and steel. It would also be well adapted for general steam raising purposes in India and for use in gas-engines.

CONCLUDING REMARKS.

In the present paper I have sought to draw attention in this country to the wealth which India possesses in her coalfields, to the present position of Indian coal mining, and to the quality of the coal mined in the different provinces, as well as to the conditions under which mining is carried on, and to the importance of Government giving careful and sympathetic consideration to the development of an industry, hardly out of its infancy, upon which the future industrial prosperity of India so largely rests.

I have drawn attention to the importance of railway communication being opened up with the undeveloped coalfields of Western Bengal, the Central Provinces, and Central India, and to the great advantage it would be to Madras and Southern India, where coal is scarce or non-existent, if communications were provided between this region and the coalfields of Western Bengal and the Central Provinces. A glance at the sketch map will show how large an area, especially that lying between Central India and Bengal, is at present without railway communication with the nearest supplies of coal.

I have alluded to the desirability of further information being obtained by Government with reference to the amount and quality of coal in several regions, especially in Western India and in Assam, with the view of opening up railway communication with those fields in which good and workable coal is proved to exist.

I have also pointed out the importance of greater care being taken by the collieries to secure uniformity in the quality of Indian coal. With reference to this, as well as to other difficulties, the question suggests itself as to whether an amalgamation of the numerous small coal companies (which number more than 200 in Bengal alone) would not be desirable, and be for the benefit of the coal industry as a whole.

The employment of native labour is certain to raise a number of important and delicate economic questions, which will require the greatest care in handling. The future success of coal-mining in India depends chiefly on native labour being organised with foresight and consideration, due regard being had to the general welfare of the class upon whose employment, for the present at any rate, the vital feature of cheap production depends.

Next in importance are the questions I have already touched upon, of railway rates, transport facilities, and adequate dock accommodation, all of which are now receiving consideration from Government.

I have taken the view that over and above the increasing demand for Indian coal for steamship and locomotive purposes, including its growing export trade in this connection, and apart from its increased use for domestic purposes, there must be in the near future a considerable call on the coal resources of India through the industrial utilisation of the great mineral wealth of the country, which only awaits an ample supply of good and cheap fuel. As I have already pointed out, by the establishment in India of a comprehensive Government School of Mines and Metallurgy, perhaps as an extension of the present school at Sibpur, a considerable impetus would be given to the development of the mineral resources of India. I trust that the Government of India may give careful consideration to this suggestion.

I am glad to learn that an English syndicate is now taking steps to establish iron smelting and steel manufacture on modern methods in Bengal, and I do not doubt that their example will be followed in other places as a better knowledge is gained of the quality of the coal and iron ore of other districts. Various metallurgical operations, including that of copper, brickmaking, earthenware, and pottery and glass manufacture, all seem to be likely developments in the industrial arts of India as soon as an abundant supply of cheap coal has been rendered accessible to the whole country. At the same time textile industries cannot fail to undergo considerable extension and take new directions.

I trust that the importance of the coal resources to our Indian Empire will justify the extent to which I have trespassed on your time in giving a general sketch of the present and future of the Indian coal industry in its principal bearings. Although the utilisation of water power in certain districts of India for the supply of electricity is likely to be accomplished in the near future, for many years to come coal will remain the principal source of energy.

In conclusion I must tender my thanks to those to whom I am indebted for much valuable information and assistance; to past and present officers of the Geological Survey of India; to the Steamship and Railway Companies; to the Indian Colliery Companies; to the Indian Mining Association; to Sir Richard Strachey and the East Indian Railway Company; to Col. Gardiner, R.E., Chairman of the Madras Railway Company; to Sir Edward Noel Walker, K.C.M.G., lately Colonial Secretary of Ceylon, who has procured for me much useful information respecting the employment of Indian coal in that colony; and to my assistant Mr. G. S. Blake, A.R.S.M., particularly for the assistance he has given me in preparing the illustrations to this paper.

APPENDIX.

TABLE I.—Quantity in Tons of Coal Produced in each Province.

	1895.	1896.	1897,	1898.	1899.	1900.
Burma	17,289	22,993	11,472	6,975	8,105	10,228
Assam	172,717	177,259	185,533	200,329	225,623	216,736
Bengal	2,716,155	3,037,920	3,142,497	3,622,090	4,035,265	4,978,492
North-West Provinces and Oudh	—	1,000	—	—	—	—
Rajputana	—	—	—	511	4,249	9,250
Central India	118,479	115,386	124,778	134,726	164,569	164,489
Punjab	72,493	79,017	92,792	85,862	81,835	74,083
Baluchistan	25,458	26,257	12,043	13,372	15,822	23,281
Central Provinces	122,776	141,185	131,629	149,709	156,576	172,842
Hyderabad—Nizam's Territory	292,915	262,681	365,550	394,622	401,216	469 291
Madras	1,737	—	—	—	—	—
Total	3,540,019	3,863,698	4,066,294	4,608,196	5,093,260	6,118,692

TABLE II.—Output for 1900 of Coal in British and Colonial Coalfields.

	Tons.
United Kingdom	225,181,300
India	6,118,692
New South Wales	5,507,497
Canada	5,332,197
New Zealand	1,093,990
Queensland	497,132
Victoria	211,596
West Australia	118,410
Tasmania	50,632

TABLE III.—Foreign Coal Trade of India.

	Imports. Coal, Coke, and Patent Fuel. Tons.	Exports. Coal and Coke. Tons.
1895-1896	761,996	80,923
1896-1897	494,960	136,719
1897-1898	261,739	212,855
1898-1899	358,880	327,104
1899-1900	422,376	304,586
1900-1901	127,318	541,445

TABLE IV.—Indian Railways.

	Foreign Coal consumed by railways. Tons.	Indian Coal consumed by railways Tons.
1896	108,442	1,182,051
1897	49,779	1,332,043
1898	39,004	1,422,103
1899	82,446	1,557,000
1900	54,339	1,855,610

TABLE V.—TABULATED RESULTS OF A PRELIMINARY EXAMINATION OF INDIAN COALS.

Indian invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding sample.	Evaporative power.	Calorific value.	Fixed carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
				ASSAM.											
*1828	3032	4 Oct. 1894	Makum	Assam Railways and Trading Company (Ledo Valley).	—	12·76	6853	53·28	1·02	54·30	45·45	1·07	Does not cake.	Pale chocolate.	A glistening black coal, clean to handle, easily broken, conchoidal fracture.
6953	7082	11 Jan. 1896	Do.	Assam Railways and Trading Company, Limited.	2 cwt. Makum coal	13·42	7205	47·84	3·66	51·50	48·50	4·87	Cakes	Reddish brown.	Very dirty and dusty coal, breaks readily with irregular fracture, alternately dull and bright.
*96	1445	4 Oct. 1894	Cherrapunji	Cherrapunji Coalfield ...	—	14·34	7702	49·54	4·74	54·28	45·72	3·98	Do.	Dark red	A dull black coal, dirty, very hard, with cuboidal fracture.
*97	1446	Do.	Maoflong	Maoflong Coalfield	—	13·27	7128	49·79	2·96	52·75	47·25	3·08	Do.	Yellowish brown.	Bright and clean with fossil resin in many places.
8293	7778	25 Nov. 1896	Dickhu Valley.	Dickhu Valley Colliery, Nazira, Assam.	—	11·22	6028	51·40	2·35	53·75	46·25	3·45	Does not cake.	Dark reddish brown	A very bright coal, black as pitch, and of conchoidal fracture; intersected with dull layers.
				BALUCHISTAN.											
*93	1441	4 Oct. 1894	Khost Colliery.	Khost Colliery, Khost seam.	—	12·35	6633	49·58	5·15	54·73	45·27	4·82	Cakes	Terra-cotta	Clean, bright and hard, but disintegrating with a white efflorescence, and with evolution of sulphuretted hydrogen.
*94	1442	Do.	Do.	Khost Colliery, Killa Hakim seam.	—	12·92	6936	41·50	9·56	51·06	48·94	0·74	Do.	Yellowish brown.	Clean, bright and hard, with obtuse fracture.
				BENGAL (RANIGANJ).											
*99	1448	Do.	Kumardubhi	Barakar Coal Company, Kumardubhi Colliery.	—	12·23	6567	51·48	13·85	65·33	44·67	0·53	Do.	Grey	Layers of dull and bright coal, clean rounded fracture.
7865	7311	13 July, 1896	Do.	Barakar Coal Company ...	One box of steam coal from Kumardubhi Colliery.	12·09	6490	51·35	14·95	66·30	33·70	0·63	Do	Dove	Dull, with bright patches, fairly tough and clean.
*1661	2865	4 Oct. 1894	Raniganj	Bengal Coal Company, Limited, Raniganj coal.	—	11·22	6028	42·05	12·35	54·40	45·60	1·58	Do.	Fawn	Bright, hard and dirty.
7994	7454	29 July, 1896	Do.	A. Whyte, Esq., Raniganj	Coal from the village of Chowrah, 4 miles east of Toposi Railway Station on the East Indian Railway, and belonging to the Raniganj series.	10·47	5621	49·59	11·15	60·74	39·26	1·47	Does not cake.	Light fawn	Dull, with bright patches, rather tough, clean.
7995	7455	Do.	Do.	Do. do.	Coal from the village Khooseree belonging to Pandra Estates, situated 8 miles N.W. of Barakar, and belongs to the Lower Barakar series. In this seam a band of 2 feet very dark and carbonaceous clay divides the seam into two, the top coal is 5 ft.	12·90	6930	59·01	11·96	70·97	29·03	1·89	Cakes	Dirty fawn	A dull silky coal with bright patches, breaks easily, clean.

					6 in. in thickness, of bright appearance, the bottom coal is 6 ft. 6 in. in thickness, and is a heavier and duller looking coal.									
8184	7758	25 Nov. 1896	Raghunath Chuk.	Jaganath Coal Company, Raniganj.	Raghunath Chuk coal ...	10·92	5863	45·03	14·97	60·00	40·00	0·64	Does not cake.	Greyish pink.	Alternate layers of bright and dull coal, dirty, breaks easily, with much dust.
*652	1996	14 Oct. 1894	Barakar	Barakar Iron Works ...	—	11·10	5962	53·49	18·33	71·82	28·18	0·62	Cakes	Greyish white	Dull, black, dirty, very hard.
7247	7099	28 Mar. 1896	Do.	New Barakar Coal Company, through G. Alexander, Esq.	Coal taken from an incline just being opened out, situated three miles from Barakar on the Jheria Branch Railway. Taken from about 10 feet below the surface.	10·09	5410	41·80	29·25	71·05	28·95	0·89	Do.	Dirty white	Dull black coal with bright patches in places, cleaves occasionally with a silky fracture, clean.
7740	7323	25 June, 1896	Rajpur	Manager, Rajpur Coal Company, Barakar.	Coal from Rajpur Colliery, as usually obtained.	11·78	63[illegible]5	55·05	18·95	74·00	26·00	0·47	Does not cake.	Do.	A dull coal with bright patches, fairly tough, conchoidal fracture.
7746	7317	26 June, 1896	Petana	Messrs. Mylne & Co., proprietors, Petana Colliery, Barakar.	Petana steam coal.	12·88	6920	54·38	10·44	64·82	35·18	0·82	Cakes	Do.	Glistening coal composed of dull and bright portion, former tough, the latter readily broken. Occurs in well-defined layers.
7865	7312	13 July, 1896	Loyabad	Manager, Barakar Coal Company.	Steam coal from Loyabad Colliery.	11·88	6380	60·54	13·04	73·58	26·42	0·87	Do.	Light grey	Exhibits a peculiar curved fracture. Part of the sample was of dull appearance and very tough, while the remainder was bright and broke readily into small fragments.
7866	7312	Do.	Do.	Do. do.	Do. (A special piece which was roughly ovoidal).	11·92	6402	55·69	18·56	74·25	25·75	0·91	Do.	Do.	
*1658	2862	4 Oct. 1894	Sodepore	Bengal Coal Company, Limited.	Sodepore coal	12·39	6655	49·95	8·48	58·43	41·57	0·29	Do.	Light yellow.	Bright, dirty, fairly hard.
*1659	2863	Do.	Liakdee	Do. do.	Liakdee coal	12·52	6721	57·70	8·62	66·32	33·68	0·53	Do.	White	Mixed dull black and glossy, the latter crumbles readily, clean.
*1660	2864	Do.	Nimcha	Do. do.	Nimcha coal	10·90	5852	42·50	14·64	57·14	42·86	0·32	Do.	Brownish yellow.	Dull and glossy laminæ, clean and hard.
8081	7453	11 Aug. 189	Jeyramdangah.	Managing Agent, New Beerbhoom Coal Company.	Coal from Jeyramdangah, new seam.	12·67	6809	51·36	10·61	61·97	38·03	0·79	Does not cake.	Terra-cotta	Alternate dull and bright layers, breaks easily in small fragments, clean.
8082	7448	Do.	Dhadka	Do. do.	Coal from Dhadka, top seam.	12·19	6545	47·85	9·68	57·53	42·47	0·35	Cakes	Flesh colour	Alternate bright and dull layers, breaks easily in small fragments with little dust, clean.
8083	7451	Do.	Belrooi	Do. do.	Coal from Belrooi	13·19	7084	51·86	8·86	60·72	39·28	0·39	Do.	Do.	Dull, with many bright patches, clean.
8084	7452	Do.	Borrea	Do. do.	Coal from Borrea, fourth seam.	13·01	6985	55·92	12·30	68·22	31·78	0·05	Do.	Dirty pink	Dull, with bright patches, breaks easily in layers, clean.
7194	7097	20 Mar. 18	Do.	Managing Agents, Borrea Coal Company.	Salanpur coal	11·57	6215	57·31	14·86	72·17	27·83	0·75	Do.	Grey white	Dull silky coal with glistening layers and patches. Hard and brittle, very clean.
*1663	2867	4 Oct. 1894	Sanctoria	Bengal Coal Company, Limited.	Coal from Desherghur, Sanctoria.	11·88	6380	49·41	11·29	60·70	39·30	1·63	Do.	Lemon yellow.	A glossy coal, hard, but with soft patches.
78[illegible]1	7321	10 July, 189	Searsole	Searsole and Jemehiri Collieries, Searsole, Rajbati.	Searsole steam coal	12·13	6512	44·25	8·87	53·12	46·88	0·33	Do.	Fawn	Alternate layers of dull and bright coal, clean, easily broken, cleaving in layers.

TABLE V.—(continued.)

Indian Invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.	Evaporative Power.	Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
7852	7320	10 July, 1896	Jemehiri	Searsole and Jemehiri Collieries, Searsole, Rajbati.	Jemehiri coal	11·77	6320	44·60	10·90	55·50	44·50	0·20	Cakes	Terra-cotta	Alternate layers of dull and bright coal, hard, dusty when broken.
*1564	2868	4 Oct., 1894	Madhubpur	Bengal Coal Company, Limited.	Madhubpur coal...	10·61	5698	38·80	17·12	55·92	44·08	1·54	Do.	Brownish yellow.	A dull coal, laminated, hard, with soft patches, clean.
*1668	2872	Do.	Sanctoria	Do. do.	Sanctoria coal	11·78	6325	49·32	10·74	60·06	39·94	1·53	Do.	Yellowish grey.	A dull coal with bright patches, hard and clean.
*1665	2869	Do.	Searsole	Do. do.	Coal from Searsole, Raniganj.	10·92	5863	42·71	12·03	54·74	45·26	1·51	Do.	Fawn	A clean bright coal, cleaving in layers.
7861	7322	13 July, 1896	Barmondia	Managing Agent, Damuda Coal Company.	Coal from Barmondia Colliery	12·83	6889	48·52	8·93	57·45	42·55	0·33	Do.	Cream	Clean, bright coal, easily broken, hard, but with soft patches.
7862	7315	Do	Luchipur	Do. do.	Coal from Luchipur Colliery.	12·29	6600	48·75	13·01	61·76	38·24	0·40	Do.	Fawn	In well-defined layers, part dull and part bright and glistening, clean, fairly tough, except that the bright layers crumble readily.
7863	7318	Do.	Ghoosick	Do. do.	Coal from Ghoosick Colliery.	11·09	5954	43·69	12·16	55·85	44·15	0·095	Do.	Light fawn	Well-defined layers of dull and bright coal, the former tough, the latter rather brittle.
7864	7316	Do.	Bharatchak	Do. do.	Coal from Bharatchak or Damuda Colliery.	12·49	6710	47·69	10·22	57·91	42·09	0·78	Do.	Fawn	Bright coal, fractures readily. Made up of a dull and bright portion. Dull portion tough, whilst the bright is readily broken.
8197	7762	Do.	Nundie	Adjai Coal Company, Limited, Nundie Colliery, Raniganj.	No. 1 Sample	12·04	6468	53·89	7·59	61·48	38·52	0·48	Does not cake.	Fawn	Alternate bright and dull layers, the dull coal being dirty to handle.
8198	7765	Do.	Do.	Do. do.	No. 2 Sample	11·41	6127	50·38	10·72	61·10	38·90	0·37	Do.	Do.	Dull slaty coal with many bright patches, rather tough, clean.
8199	7774	Do.	Kalipahari	Srikistopore Coal Company, Kalipahari.	Steam coal	11·39	6116	48·76	10·47	59·23	40·77	0·34	Do.	Reddish grey.	A bright coal, with some duller layers.
8261	7757	Do.	Patlabari	South Barakar Coal Company, Patlabari Colliery, No. 2 Seam.	—	12·41	6560	57·15	11·30	68·45	31·55	0·63	Do.	Do.	Dull coal with bright layers, easily broken with much dust, dirty to handle.
8292	7761	Do.	Seebpore	Katras-Jheria Coal Company, Limited, Churnpore, Asansole, East Indian Railway, Seebpore Colliery.	Large lump	10·80	5830	54·58	8·31	62·89	37·11	0·45	Does not cake.	Fawn	Alternate dull and bright layers, very dirty, breaks easily with much dust.
8292A	7763	25 Nov., 1896	Seebpore	Katras-Jheria Coal Company, Limited, Churnpore, Asansole, East Indian Railway, Sheebpore Colliery.	Small pieces...	10·88	5841	52·15	8·28	60·41	39·59	0·51	Does not cake.	Light fawn	Alternate dull and bright layers, breaks easily, clean

			BENGAL (KARHARBARI).												
*636	1980	4 Oct., 1894	Karharbari	East Indian Railway, Karharbari Colliery, Jogiland seam."	—	13·11	7040	56·45	10·77	67·22	32·78	0·51	Do.	White	Laminated, very clean, cleaves in small cubes.
*639	1983	Do.	Do.	East Indian Railway, Karharbari Colliery, Lower seam.	—	12·37	6644	64·80	7·37	72·17	27·83	0·42	Does not cake.	Dark yellow	Dull, black, clean, not very hard.
*641	1985	Do.	Do.	East Indian Railway, Karharbari Colliery, Upper seam.	—	13·01	6985	66·80	5·35	72·15	27·85	0·40	Do.	Yellowish brown.	Dull black, hard, clean, breaks into cubes.
7044	7081	31 Jan., 1896	Do.	Manager, Giridih Colliery Company, Limited.	(Karharbari Lower Seam) from Pit Paharidih, Giridih Coalfield.	12·13	6512	58·59	14·55	73·14	26·86	0·45	Cakes	Dove	Dull, rather tough, breaks in every direction with little dust.
6817	7070	6 Jan., 1896	Girihdih	Superintendent, Bengal Coal Company, Limited.	Steam coal, Giridih	13·37	7183	60·93	9·99	70·92	29·08	0·43	Do.	Buff	Clean, but rather dusty, crumbles readily, bright in layers.
*1652	2866	Do.	Kooldeah	Do. do.	Kooldeah coal	12·39	6657	64·20	12·08	76·28	27·72	1·50	Do.	White	A dull black coal, clean and hard.
			BENGAL (JHERIA).												
8192	7768	25 Nov., 1896	Chattabad	Katras-Jheria Coal Company, Limited, Katras Collieries, Manbhum.	Chattabad, No. 12 Seam...	12·70	6820	62·17	11·38	73·55	26·45	0·85	Do.	Greyish red	A clean, rather bright coal, easily broken.
8193	7770	Do.	Moulkara	Do. do.	Moulkara, East Colliery, No. 13 Seam.	12·66	6798	62·60	10·55	73·15	26·85	0·93	Do.	Dirty white	Laminated bright coal, dirty, breaks very easily, with much dust.
8194	7769	Do.	Do.	Do. do.	Moulkara, South Colliery, No. 14 Seam.	12·42	6672	58·85	14·36	73·21	26·79	0·83	Do.	Do.	Dull coal with bright layers, clean.
8195	7771	Do.	Do.	Do. do.	Moulkara, West Colliery, No. 15 Seam.	11·84	6358	58·64	13·15	71·79	28·21	0·75	Do.	Reddish grey.	Bright coal in layers, clean.
8195	7772	Do.	Choitoodee	Do. do.	Choitoodee, No. 15 Seam...	12·64	6787	61·24	11·46	72·70	27·30	0·93	Do.	Dirty white	Bright coal in layers, breaks easily, clean.
8329	7767	Do.	Kustore	Raniganj Coal Association, Limited, 4, Fairlie Place, Calcutta.	Coal from Kustore Colliery, Jheria.	12·41	6666	63·71	8·58	72·29	27·71	0·61	Cakes	Reddish white.	Dull coal with graphitic lustre in oval pieces, and conchoidal fracture, breaks easily in layers with some dust, clean to handle.
8723	8120	25 Feb., 1897	Koiloodee	Jheria Coal Company, Katras Collieries, Manbhum.	Koiloodee, No. 12 Seam...	11·92	6402	60·23	15·90	76·13	23·87	0·83	Do.	Dirty white	Rather bright coal with a silky lustre, breaks easily with some dust.
8260	7766	Do.	Kustore	Raniganj Coal Association, Limited.	Coal from Kustore Colliery, Jheria.	12·37	6644	63·21	9·14	72·35	27·65	0·50	Cakes	Do.	Dull coal with bright layers, clean.
7248	7100	28 Mar., 1896	Jheria	Bengal-Nagpur Coal Company, Limited, through George Alexander, Esq.	Coal taken from inclines at Buggutdeah in Jheria.	10·70	5747	56·35	17·88	74·23	25·77	0·90	Cakes	White	Bright, glistening coal, brittle and hard, in places has a pitchy appearance.
7249	7101	Do.	Do.	Do. do.	Coal taken from a quarry at Buggutdeah. These two samples are not only surface coal, but have been exposed to the atmosphere.	10·24	5500	54·25	24·20	78·45	21·55	0·70	Do.	Light grey	Dull black coal with bright patches in places, cleaves occasionally with a silky fracture, rather hard, fairly clean.
			BENGAL (DALTONGANJ).												
7145	7090	6 Mar., 1896	Daltonganj	Dr. Saise, through Station Master, Gya.	Daltonganj coal, Rajhira seam.	10·41	5591	62·35	14·04	76·39	23·61	0·92	Does not cake.	Yellowish brown.	Bright coal, rather hard, not very dirty, on some pieces a small amount of white deposit.

TABLE V.—(*continued.*)

Indian Invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.	Evaporative Power.	Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
			BURMA.												
*3531	6157	4 Oct., 1894	Letkokbin	Burma Coal Company, Limited.	From roof of seam	—	†	33·57	8·50	42·07	57·93	0·33	Does not cake.	White	Dull black, clean and hard with rounded surfaces and fracture.
*3532	6158	Do.	Do.	Do. do.	From floor of seam	—	†	3·58	68·39	†	28·05	0·11	Do.	Do.	Dull black, with glossy patches, very soft and soapy to touch, clean.
			CENTRAL INDIA.												
*256	1605	Do.	Umaria	Umaria Colliery...	—	10·04	5390	59·65	23·63	83·28	16·72	0·32	Do.	Do.	A clean dull coal with irregular cleavage, easiiy broken.
*322	1671	Do.	Do.	Do.	—	9·77	5247	55·97	26·60	82·57	17·43	0·43	Do.	Greyish white.	Dull, soft, clean, and contains fossilized resin
7093	7091	15 Feb., 1896	Do.	The Manager, Umaria Colliery.	Sample from No. 3 Seam, Middle area.	11·06	5940	63·63	15·99	79·62	20·38	0·76	Do.	White	Small quantities of white substance between the layers in places. Rather dirty to handle.
7094	7092	Do.	Do.	Do. do.	Sample from No. 2 Seam, Middle area.	10·14	5445	56·66	23·17	79·83	20·17	1·03	Do.	Do.	Similar to 7094.
7095	7093	Do.	Do.	Do. do.	Sample from No. 2 Seam, Northern area.	9·94	5337	45·99	14·94	60·93	39·07	1·02	Do.	Do.	Similar to 7094. Traces of iron pyrites in cleavages, rather tough.
7096	7094	Do.	Do.	Do. do.	Sample from No. 3 Seam, Northern area.	10·21	5481	50·38	14·98	65·36	34·64	1·81	Do.	Do.	Similar to 7094 and 7095, but not so dirty to handle. It also shows a silky patched appearance when cleaved.
7927	7449	22 July, 1896	Do.	Do. do.	Sample from No. 4 Seam, Northern area.	10·55	5665	43·42	21·07	64·49	35·51	1·89	Do.	Reddish white.	Tough coal of dull appearance, cleaving in layers.
7928	7450	Do.	Do.	Do. do.	Samples from No. 4 Seam, Middle area. "Information required as to their coking properties."	10·83	5819	48·99	24·28	73·27	26·73	2·03	Do.	Dirty white	Dull, with small bright patches, irregular cleavage, easily broken, with much dust, dirty.
			CENTRAL PROVINCES.												
*1648	2852	4 Oct., 1894	Mohpani	The Nerbudda Coal and Iron Company, Limited, Mohpani Coal Mine.	From No. 1 Seam	9·50	5104	42·46	24·30	66·76	33·24	0·50	Do.	Brownish yellow.	Dull, laminated, very hard, fairly clean.
8284	7775	Do.	Do.	Do. do.	Sample A	11·84	6358	49·83	8·88	58·71	41·29	0·52	Do.	Light fawn	A shaly coal, dull, with bright spots in layers, breaks easily, dirty, gives much dust.
8285	7776	Do.	Do.	Do. do.	Sample B	11·80	6336	60·64	8·33	68·97	31·03	0·47	Do.	Do.	A dull coal, very light, breaks easily, much dust, very fibrous.
8286	7777	Do.	Do.	Do. do.	Sample C	9·42	5060	50·81	11·93	62·74	37·26	1·03	Do.	Terra-cotta	A dull coal with some bright layers, breaks easily with much dust, very dirty.
*316	1665	—	Warora	Warora Colliery	—	10 30	5533	41·40	13·50	54·90	45·10	0·94	Do.	White	Dull, with bright patches, clean and rather soft.

† Does not burn readily.

*318	1667	—	Do.	Do. do.	—	10·24	5570	40·97	12·78	53·75	46·25	1·21	Do.	Do.	A clean silky coal, easily broken, cleaving in cubes.
8130	7779	1 Sept. 1896	Warora	Manager, Warora Colliery.	From No. 2 Pit	10·27	5514	39·96	11·86	51·82	48·18	0·98	Does not cake.	Greyish white.	Slaty dull coal with some brighter patches, rather dirty.
8131	7760	Do.	Do.	Do. do.	From No. 4 Pit	9·46	5082	43·12	15·80	58·02	41·08	2·37	Do.	Do.	Same as 8130.
8132	7759	Do.	Do.	Do. do.	From No. 5 Pit	9·93	5335	44·57	12·75	57·32	42·68	0·77	Do.	Dirty white	Same as 8130.
8133	7773	Do.	Do.	Do. do.	From No. 1 Seam, No. 2 Pit.	9·01	4840	40·97	20·75	61·72	38·28	0·64	Do.	Slightly yellow.	Slaty dull coal with only a few bright spots, dirty, rather tough.
*1619	2853	4 Oct. 1891	Mohpani	Gadawarra	No. 2 Seam	9·91	5324	42·61	20·13	62·74	37·26	0·39	Cakes.	White.	Dirty, alternate layers of dull and very hard coal and bright coal easily broken.
*1650	2854	Do.	Do.	Do. do.	No. 3 Seam	10·36	5566	41·00	19·65	60·65	39·35	0·44	Do.	Yellowish brown.	
*1651	2855	Do.	Do.	Do. do.	No. 4 Seam	11·39	6116	45·35	9·23	54·58	45·42	0·43	Do.	Light yellow.	Dull, hard and clean with occasional glossy layers.
			NIZAM'S DOMINIONS.												
*87	1436	—	Singareni	Hyderabad	—	10·32	5544	43·55	12·71	56·26	43·74	0·29	Does not cake.	Yellowish brown.	Irregular fracture, extremely hard, dull, clean coal, with thin streaks of glossy coal.
7803	7308	—	Do.	Agent and General Manager, Hyderabad (Deccan), Company.	Singareni coal	10·96	5885	54·68	8·61	62·84	37·16	1·28	Cakes slightly.	Dark fawn	Very tough, dull, with bright patches.
				PUNJAB.											
7070 and 7071	7083 and 7084	3 Feb. 1896	Dandot	Mining Manager, Colliery District, North-Western Railway.	Two boxes of Dandot steam coal.	11·16	5995	38·32	13·10	51·42	48·58	1·86	Does not cake.	Reddish white.	Dull, with bright patches, easily broken, clean.
7072 and 7073	7085 and 7086	Do.	Pidh	Do. do.	Two boxes of Pidh steam coal. These are very friable and deteriorate rapidly if exposed to the air, and when in bulk are apt to fire by spontaneous combustion.	11·61	6237	39·44	10·00	49·44	50·56	3·20	Do.	Flesh colour.	Clean, rather bright, easily broken, with little dust.
7109 and 7110	7313 and 7314	25 Feb. 1896	Bhaganwala	Do. do.	Two boxes of Bhaganwala coal.	8·98	4820	29·54	36·58	66·12	33·88	2·24	Cakes slightly.	Dirty yellow.	Dull, breaks readily with irregular fracture, white substance, brown resin.
						7·95	4270	27·79	39·91	67·7	32·30	2·18	Do.	Flesh colour.	Similar to 7109.
7118	7095	13 Feb. 1896	Pidh	Do. do.	Pidh Shale. It is believed to contain mineral oil and is known to contain gas. Precise information desired on these points.	8·32	4470	27·30	31·93	59·23	40·77	4·41	Does not cake.	Dirty white.	This shale is in layers. A resinous substance is found occasionally between the layers. Mineral oil by distillation, small. Yield of gas low, illuminating power deficient.
7134	7096	25 Feb.	Dandot	Do. do.	Dandot Shale, the same information desired as above (Pidh Shale).	3·62	1943	12·84	60·99	78·83	26·17	2·86	Do.	Light fawn	Dull, grey black coal with soapy touch. Contains a small quantity of brown resinous matter. Mineral oil very small, yield of gas very low illuminating power, small.
7692	7319	20 April, 1896	Shahrig	Executive Engineer, Shagrig District, North-Western Railway.	Takrai top seam coal from Mainway, West.	12·53	6730	38·74	11·81	50·55	49·45	1·67	Cakes.	Creamy brown.	Easily broken, a quantity of a micaceous substance between the layers.

The calorific power has been determined by means of Thompson's calorimeter, the apparatus having been previously standardised by the combustion of material of known calorific value, and the necessary corrections applied to the experimental numbers which are expressed in calories representing the number of grams of water raised 1°C. in temperature, by the combustion of 1 gram of coal.

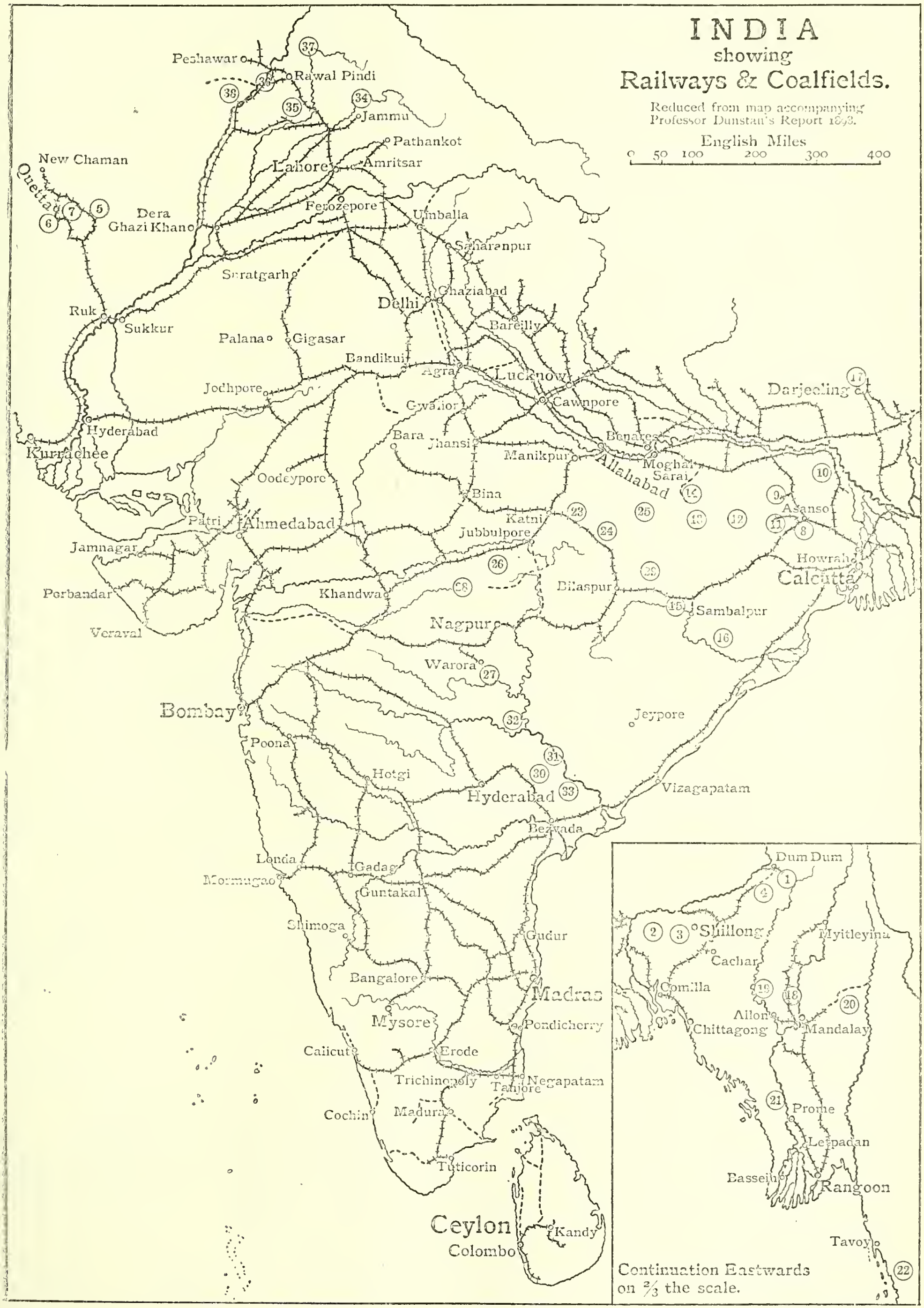
The evaporative power is represented by the number of pounds of water at 100°C converted into steam at the same temperature by the combustion of 1 lb. of coal. These numbers have been calculated from the calories by dividing by the latent heat of steam.

TABLE VI.—RESULTS OF ULTIMATE ANALYSES OF SELECTED INDIAN COALS.

Indian Invoice Number.	Province and Mine.	Carbon.	Hydrogen.	Ash.	Moisture.	Sulphur.	Nitrogen, Hydrogen, &c.
	ASSAM:—						
1828	Makum	77·31	5·43	1·27	3·07	1·02	11·00
96	Cherrapunji	77·75	5·83	4·74	1·45	3·98	0·25
97	Maoflong	75·05	5·17	3·23	3·15	3·08	10·32
	BALUCHISTAN:—						
93	Khost	71·38	4·97	5·57	3·85	4·82	9·41
94	”	70·58	5·55	10·64	2·46	0·74	10·03
	BENGAL:—						
99	Kumardubhi	70·43	4·70	13·85	1·86	0·53	8·63
	Karharbari						
639	Lower Seam	80·75	4·32	7·37	1·23	0·42	5·91
541	Upper Seam	83·53	4·59	5·35	1·28	0·40	4·85
1658	Sodepore	72·09	4·87	9·03	3·54	0·29	10·18
1659	Liakdee	74·33	4·60	9·29	2·23	0·53	8·02
	BURMA:—						
3531	Letkokbin	60·25	4·64	9·28	11·55	0·33	13·95
	CENTRAL PROVINCES:—						
1651	Mohpani	67·65	4·37	9·73	7·07	0·43	10·75

KEY TO THE SKETCH-MAP OF INDIAN COALFIELDS.

Assam—		
(1)	Makum	Collieries.
(2)	Daranggiri	Prospective.
(3)	Cherrapunji	Worked.
	Lakadong	Prespective.
	Maoflong (Maobelarkar)	Worked.
(4)	Disai Jaipur	Prospective.
	Nazira	Colliery.
Baluchistan—		
(5)	Khost	Collieries.
(6)	Mach	Prospective.
(7)	Quetta	Worked
Bengal—		
(8)	Raniganj and Barakar	Collieries.
(9)	Karharbari (Giridih)	Collieries.
(10)	Rajmahal	5 fields, little worked.
(11)	Jheria	Collieries.
(12)	Bokaro Ramgarh Karanpura N. &. S.	Prospective.
(13)	Aurunga Hutar	Prospective.
(14)	Daltonganj	Worked.
(17)	Darjeeling, Tista R.	Prospective.
Burma—		
(18)	Thingadaw	Working.
(19)	Chindwin	Prospective.
(20)	Lashio	
(21)	Thayetmyo Henzada	Very poor.
(22)	Mergui	
Central India—		
(23)	Umaria	Colliery.
(24)	Sohagpur, &c.	Prospective.
(25)	Singrowli Bisrampur, &c.	Prospective.
Central Provinces—		
(26)	Mohpani	Colliery.
(27)	Warora (Chanda, &c.)	Colliery.
(28)	Pench, Kanhan and Tawa Shahpur, Singora, Barkoi	Prospective.
(29)	Korba Mand Raigarh-Hingir	
(15)	Eeb R. (Rampur)	Prospective.
(16)	Talchir	
Nizam's Dominions and Madras (Godavari Valley)—		
(30)	Singareni	Colliery.
(31)	Kamarum Cherla	Prospective.
	Rajahzompalli	Colliery.
(32)	Chinnur	
(33)	Madavaram Beddadanol	Prospective.
Kashmir—		
(34)	Sangar Marg	Prospective.
Punjab—		
(35)	Pidh and Bhaganwala	Collieries.
	Dandot	Colliery.
(36)	Chita Pahar	Poor.
(37)	Hazara (Abbottabad)	
(38)	Bannu	
Rajputana—		
(39)	Palana (Bikanir)	Colliery.



Walker & Cockerell sc.

TABLE VII.—OTHER RECORDED ANALYSES OF INDIAN COALS.

Province and Mine.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Specific Gravity.	Calorific Power Calories.	Evaporative Power (Calculated).	Caking Properties.	Colour of Ash.	References.
ASSAM.											
Cherrapunji … … … … … … …	…	37·1	62·0	0·9	…	…	…	…	…	…	J. Princep.
Langrin Coalfields, Khasia Hills											
Seam No. 1 … … … … … ..	5·84	35·16	50·40	8·60	…	…	…	…	Non-caking	Pale Red	T. D. La Touche, Records of G.S., xvii. 1884.
Seam No. 2 … … … … … ..	3·02	39·58	50·80	6·60	…	…	…	…	Cakes.	Red	
Daranggiri, Khasia Hills											
No. 1 (7 ft. 6 in. Seam) … …	11·5	33·1	47·7	7·7	…	…	…	..	…	…	La Touche. Rec. G. S., xv. 1882.
No. 2 (Nengja Stream 3 ft. 6 in. Seam) … ..	6·2	39·4	51·8	2·6	…	…	…	…	…	…	
Khasia Hills											
Maobelarkar … … … … …	3·4	39·6	55·2	1·8	…	…	…	..	. .	..	Rec. G.S., viii.
Average of 27 analyses of Assam Coal … … … … … … …	…	36·2	60·0	3·8	…	…	…	…	…	…	Ball's Geology.
Chittagong, A … … … … ..	…	38·0	36·5	25·5							
,, B … … … … ..	…	35·8	25·9	38·3							
Assam Coal … … … … … … ..	…	44·98	53·42	1·60	2·52	…	…	13·99	…	…	T. H. Ward, Handbook.
Makum … … … … … … …	…	46·5	53·0	2·0	…	…	…	…	…	…	Handbook.
Do. (average) … … … … …	…	23·18	75·70	1·12	…	…	…	…	…	…	F. R. Mallet. 1876.
BALUCHISTAN.											
Khost Colliery … … … … …	2·20	40·56	47·48	9·76	…	…	…	…	Cakes, forms light coke.	Grey.	
Sharigh … … … … … … … ..	3·56	42·60	40·12	13·72	…	…	…	…	Cakes.	Grey.	
Harnai, No. 1 (2 miles S.W.) … …	8·12	37·64	51·04	3·20	…	…	…	…	Sinters slightly.	Dark brown	
Do. No. 2 … … … … … … ..	8·60	34·84	49·56	7·00	…	…	…	…	Sinters slightly.	Dark red.	
BENGAL.											
Raniganj.											
(Gangootiya) Sanctoria … … … … … … …	3·20	32·65	54·9	9·25	·55	…	…	…	Fairly hard coke.	Brown.	Bengal Nagpore Coal Co., 1901.
Bhuggutdih.											
No. 11 Seam … … … … … …	·70	21·55	63·20	14·55	·79	1·40	…	…	Hardcoke	White.	
No. 12 Seam … … … … … ..	·50	22·45	62·05	15·00	·82	1·39	…	…	Fairly hard coke.	White.	
No. 13 Seam … … … … … ..	(·62)	27·46	62·20	10·34	·80	1·38	…	…	Hardcoke	Greyish	
Dhadka … … … … … … … ..	…	42·47	47·85	9·68	…	…	6545	…	Cakes.	…	New Beerbhoom Coal Co., 1901.
Belrooi … … … … … … … ..	…	39·28	51·86	8·86	…	…	7081	…	Cakes.	…	
Borrea … … … … … … … …	…	31·78	55·92	12·30	…	…	6985	…	Cakes.	…	
Joyramdangah … … … … ..	…	38·03	51·36	10·61	…	…	6809	…	Cakes.	…	
Barmondia … … … … … …	…	32·45	54·65	10·55	…	…	6889	…	Cakes.	…	Damuda Coal Co., 1901.
Luchipur … … … … … … … …	…	31·30	57·90	8·05	…	…	6600	…	Cakes.	…	
Nursemuda … … … … … … ..	…	33·65	45·25	15·90	…	…	…	…	Cakes.	…	
Desherghur … … .. … … ..	2·64	37·57	50·75	9·04	…	…	…	…	…	…	W. C. Anderson.
Barakar … … … … … … …	1·92	31·98	57·27	8·83							
Ghussick … … … … … … ..	1·35	24·11	61·72	12·82							
Chota Dhemo … … … … … ..	3·30	37·00	48·49	11·21							
Average of 31 … … … … … …	…	30·63	53·9	16·17	…	…	…	…	…	…	Handbook. 1900, P. N. Bose.
North Bengal Coal Company, Upper Seam … … … … …	…	14·79	74·31	10·43	0·47	…	…	…	…	…	Dr. Saise, Handbook.
Alipore (average) … … … … …	…	20·81	60·86	14·63	1·36	…	…	12·89	…	…	T. H. Ward.
Barakar … … … … … .. …	…	27·63	64·26	7·27	1·56	…	…	…	…	…	T. H. Ward.
Dhadka … … … … … … …	…	42·75	49·61	7·64	…	…	…	…			
Borrea … … … … … … …	…	29·27	60·70	10·03	…	…	…	12·35			
Belrooi … … … … … … ..	…	36·75	53·70	9·59	…	…	…	12·40			
Average of 16 … … … … … …	…	32·65	51·08	16·27	…	…	…	…	…	…	Mem. Geol. Survey.
Good Specimen … … … … ..	…	37·50	51·80	10·70	…	…	…	…			
Karharbari.											
Lower Seam … … … … ..	…	24·00	66·84	9·15	0·42	1·35	…	13·20	Cakes.	Fawn.	Dr. Saise Proc. N. of England Inst. M.E. XXX.
Do. … … … … …	…	20·82	67·51	11·67	0·72	1·37	…	12·93	…	White.	
Do. … … … … …	…	25·50	64·67	9·53	0·84	1·34	…	13·20	Cakes.	Fawn.	
Upper Seam … … … … ..	…	27·59	60·46	11·96	0·52	1·33	…	12·50	do.	White.	
Bhadua Seam … … … … ..	…	25·37	61·03	13·60	0·80	1·40	…	12·40	do.	Grey.	
Do. … … … … …	…	20·46	61·45	18·08	…	1·40	…	12·26	…	Grey.	
Average … .. … … … ..	…	24·01	63·66	12·33	0·66	1·38	…	12·75	…		
Khundida Seam (Giridih coal) …	…	18·58	59·10	22·32	…	…	…	11·00			
Bengal Coal Company … … ..	…	25·54	60·30	14·16							
Jheria Coalfield.											
Lodna … … … … … … …	1·50	25·60	65·10	7·80	·47	…	…	…	Cakes.	…	Turner, Morrison, and Co., 1901.
Do. … … … … … … ..	1·40	28·80	64·20	5·60	·45	…	…	13·52	Cakes.		
Do. … … … … … … ..	1·72	29·08	58·85	10·35	·50	…	…	13·12	Cakes.		
Do. … … … … … … …	1·40	27·88	59·28	11·44	…	…	…	…	…	…	W. G. Anderson.
Kussinda … … … … … ..	1·46	26·16	57·17	15·21	…	…	…	…	…	…	Do.

TABLE VII.—*Continued.*

Province and Mine.	Moisture.	Volatile Matter.	Fixed Carbon	Ash.	Sulphur.	Specific Gravity.	Calorific Power Calories.	Evaporative Power (Calculated.)	Caking Properties.	Colour of Ash.	References.
No. 13 Seam (Jamooni)	...	28·29	58·24	13·47	...	...	...	...	Cakes.	...	T. H. Ward, 1892. Rec. XXV.
No. 13 Seam (Perghabad)	...	29·80	60·00	10·20	...	...	...	13.30	Cakes.	...	
No. 12 Seam (Ekra)	...	26·28	61·36	12·36	...	...	...	...	Non-caking.	...	
No. 17 Seam (Seetanalla)	...	32·19	57·58	10·23	...	...	...	...	Cakes.	...	
Palamow (average)	...	31·77	56·49	11·74	...	...	...	...	Non-caking.	...	Dr. Saise.
Karanpura ,,	...	27·0	64·5	8·5	...	...	...	...	...	...	Ball's Geology. Mem. XV., 12, 111.
Aurunga ,,	6·7	29·2	36·5	27·5	...	...	...	...	...	...	
Hutar ,,	5·05	28·0	55·35	10·7	...	...	...	...	...	...	
Daltonganj ,,	3·45	21·05	64·8	10·7	...	...	...	...	...	...	
Bisrampur											
Rehr River	(5·5)	38·2	57·7	4·1	...	...	...	...	...	...	Rec VI, 1873.
Pasang River	...	37·0	56·2	6·8							
Darjiling Class A.											
Lisu Valley	14·54	8·86	63·96	12·64	...	...	...	...	...	...	Bose. Rec. XXIII., p. 255, 1890.
Do. (minus water)	...	10·37	74·84	14·79							
Lisu Valley	4·72	22·16	60·24	12·88							
Do.	3·28	20·60	60·12	16 00							
Average 8, Assay Class A & B	...	22·94	59·56	17·42							
Burma.											
Murray Coal Company	...	36·44	50·0	13·36	...	...	...	13·06			
Shwebo (Burma Company), seven outcrops:—											
Lwindaw	18·42	32·10	47·62	1·86	...	...	...	12 8	Non-caking.	Pale buff	
Ketsobin, No. 1	12·60	37·22	41·72	8·46	...	...	...	10·4	do.	do.	
Do. No. 2	9·52	29·84	21·56	39·08	...	...	...	6·3	do.	do.	
Letkokbin, No. 1	11·94	37·68	36·22	14·16	...	...	...	10·5	do.	do.	
Do. No. 2	9·16	34·24	24·28	32·32	...	...	...	8·1	do.	do.	
Chadouk	8·14	31·94	24·56	35·36	...	...	...	7·5	do.	do.	
Kodaung	9·10	33·32	35·88	21·70	...	...	...	6 7	do.	do.	
Letkokbin Seam, top coal	12 45	33·85	46·60	7·10	...	...	...	...	...	...	Handbook.
Do. bottom coal	10·02	36·25	38·80	14·90							
Kyetsobin Outcrop, top coal	5·62	42·73	44·20	7·45							
Do. bottom coal	8·55	40·60	36 65	14·23							
Kadoung	6·22	33·03	36·85	23·90							
Luindaha	11·42	29·98	36·10	22·50							
Upper Chindwin (average of 11)	10·14	34·59	49·95	5·30							
Mergui, Great Tenasserim River A	15·20	30·08	30·86	23·86							
B	10·80	27·36	42·52	19·32							
C	11·34	36·40	43·27	8·99							
Kale Creek Coal, Chindwin Valley	...	37·60	59·29	3·11	...	...	...	...	...	...	Review of Mineral Production, 1896.
Letkokbin	...	40·81	55·71	3·48							
Central India.											
Umaria	(5·46)	25·17	65·71	8·12							
Korar	5 04	12·56	65·48	16·92	...	...	...	...	...	...	Hughes, Mem. XXI., 1885.
Johilla	...	36 64	55·93	7·43							
Do.	...	35·60	52·77	11·63							
Umaria	...	28·40	60·70	10·90							
Do.	...	25·40	60·90	12 70							
Sohagpur	5·8	29·5	55·0	9.7							
Do. Nandnah Seam	...	23·84	62·50	13·66							
Do. do.	...	26·55	62·89	10·56							
Do. Bhalmuri Seam	6·7	28·2	59·6	5·5							
Kurasia, 13 ft. 6 in. ,,	(2·2)	29·15	64·65	6·20							
Do. 6 ft. 6 in. ,,	(6·84)	32·43	59·95	7·62							
Sohagpur.											
Amlei Seam	5·2	22·2	57·2	15·4	...	...	...	...	...	...	G. F. Reader, Gen. Rep., 1899 to 1900.
Sone Seam	...	27·4	01·0	11·6							
Central Provinces.											
Mohpani	...	12to22	67to70	10to15	1·00	...	...	...	...	...	Handbook.
Warora, large coal	...	40·0	45·6	14·4	...						
Do. slack coal	...	49 4	35·5	24·0	...						
Do.	...	40·4	45·4	14·2	...	...	...	...	...	...	Ball's Geology.
Ghugus (average of 16)	...	33·49	45·61	20·90	...						
Warora (average)	...	48·16	42·85	8 99	0·849	...	...	...	...	...	Handbook.
Pisgaon	...	19·2	65 1	15·7	...	...	...	...	...	...	Ball's Geology.
Johilla (1882) not worked	...	28·50	57·95	13·55	...	...	...	...	...	...	Handbook.
Nizam's Dominions.											
Singareni, A	...	22·6	62·4	15·00							
Do. B	...	23·0	66·0	11·00							
Do.	...	32·0	56·0	12·00							
Do.	...	25·10	58·0	10·14	1·20						
Punjab.											
Quetta coal (North-West Frontier)	...	42·08	51·86	4·06	...	...	...	...	...	...	Handbook.
Rajputana.											
Palana	8 20	42·72	39·28	9·60	...	...	...	13·58	...	...	Rec. XXX. p. 122.

TABLE VIII.—Typical British Coals.

	Volatile Matter.	Fixed Carbon.	Ash.	Moisture.	Sulphur.	Calorific Value.		References.
Glamorganshire	10·4	86·4	3·2	...	.62	8444	...	Mr. Reddrop, L. & N.W. Ry. Co
Monmouthshire	17·5	76·4	6·1	...	·74	8327	...	
Staffordshire	34·5	62·7	2·8	...	1·33	7978	...	
Lancashire	32·6	59·9	7·5	...	0·62	7552	...	
Scotch (main)	35·84	53·79	1·28	9·09	...	7590	...	W. C. Anderson.

TABLE IX.—Analyses of Indian Coal and Coke.

	Volatile Matter.	Fixed Carbon.	Ash.	Moisture.	Sulphur.	Calorific Value.		References.
Giridih—								R. H. Mahon.
Unwashed coal	26·0	60·6	13·0	...	0·4	...	...	
Washed coal	30·2	60·24	9·56		...	...	...	
Coke (from do.)	...	86·97	12·0	0·40	0·63	...	Hard and dense.	
Sanctoria—								
Unwashed coal	38·00	49·57	12·00	...	0·43	...	...	
Washed coal	...	...	11·5		...	...	.	
Coke (from do.)	...	81·57	17·25	0·70	0·48	...	Light and porous.	
Kenwadih—								
Unwashed coal	23·5	63·5	12·5	...	0·50	...	...	
Washed coal	...	...	9·45		...	..	.	
Coke (from do.)	...	82·65	16·10	0·40	0·85	..	Hard and dense.	
Kustore—								
Unwashed coal	24·05	60·1	15·10	...	0·75	...	...	
Coke (from washed coal)	...	82·15	16·70	0·33	0·82	...	Hard and dense.	

DISCUSSION.

Mr. F. R. Upcott, C.S.I. (Government Director of Indian Railway Companies) thought a glance at the diagrams exhibited by Professor Dunstan would indicate that the peculiarity of the coalfields in India was their distance from great cities and towns where manufactories were carried on. In that connection, the question of the transport and handling of coal was really the keynote of the proper utilisation of coal in India. He thought he could, in a more homely manner, illustrate the respective values of Indian coal, by the following illustration. A coal-scuttle full of Giridhi coal would boil a certain amount of water; while eight-tenths of a scuttle full of Welsh coal, one-half of a scuttle of patent fuel, a scuttle and a-half full of Barakar coal, two scuttles of lignite coal, and two and a-half scuttles of wood, would respectively produce the same result. At the present time, Bengal coal was mostly used in India. Coal of a very inferior quality sometimes was used on the railways; in fact, when he was in the North of India, a few months ago, a North-Western driver, who had been fined on account of his train being late, appealed to him in the following pathetic manner: "How can I run my train to proper time, if I am given coal that smells like a drain, and burns like a flint?" The consumption of coal might be classed under several heads. First, there were the flour, cotton, glass, and jute mills, which required coal to work their machinery. Secondly, there was the production of power in railways and steamers. Thirdly, the manufacture of iron and steel, glass, lime and bricks. Fourthly, export; and he supposed that Calcutta would always remain the place from which coal was shipped on account of that port being nearest to the big mines. Lastly, there was the possible domestic use of coal. Those who had lived in India knew that the natives would not cook their food with coal, but used wood and charcoal. Lord Curzon, in addressing the tea planters said:—"Why do not you teach some of the 300,000,000 natives of India to drink tea; and thereby obtain a new market for your produce?" He (Mr. Upcott) did not see why the many millions in India should not be taught to use coal for cooking purposes. If that were done, an enormous development would take place in the coal consumption, but to carry out such a plan, the coal must be brought within the natives' reach. Professor Dunstan had spoken of the necessity for cheaper and better means for transport. The present rate for transport was one farthing, or less, per ton per mile. Speaking as a private individual, he thought that the railways should be allowed a free hand to reduce the rates below that figure if they chose to do so. Similarly, in regard to the size and type of rolling stock for coal transport, the railway companies ought to be, as they probably were, the judges of what was best for their own requirements. It must be remembered, however, that the position of the collieries in India was entirely different from that of the collieries in England. In this country the mines were a very short distance from the sea-board, and speaking generally, the loaded trucks were run from the mines down an incline to the ships. The trucks, which had a capacity of eight or ten tons, were put straight into a lift, by means of which the coal was tipped into the steamer's hold straight away, there being plenty of vessels ready to be loaded, and no scarcity of wagons. In India, there were some railways which had direct connection with the sea-board, and could carry coal very much cheaper than other lines as long as import traffic was also possible. With reference to what was sometimes said as to the inability of the Government to provide trucks, he happened to be at one of the Indian coal pits when he saw a very large amount of coal on the bank waiting to be carried away, and a gentleman who was with him remarked: "Here is an instance of insufficient trucks." He (Mr. Upcott) thereupon asked the manager of the mine why he did not get trucks for the coal. The reply was: "If I wanted trucks I could get them to-morrow." It appeared that the reason why the coal had not been transported was that it had been bought for shipment on board steamers as bunker coal. The steamers had not arrived at Calcutta, and it was cheaper to leave the coal at the pits' mouth than to have it sent to the Calcutta docks and lifted again. With regard to the question ot the manufacture of iron and steel, which would no doubt very shortly attain very large proportions, the earlier efforts did not succeed because those interested in the matter tried to bring the coal to the ore. He had recently had an opportunity of going over the Dowlais Works, which were situated quite close to the collieries, and he there saw ore coming into the works from Spain. If the iron and steel industry of India was to be developed it was essential that the ore should be taken to the districts where coking coal was most abundant. Although he might perhaps be called a pessimist, he thought a great deal ought to be done in the direction of carrying coal at very much cheaper rates. With electrical enterprise springing up all around them, he thought it behoved the railway companies to do all they could to foster the distribution and the consumption of coal by lowering the rates as much as possible, and by using every possible appliance to minimise labour.

Mr. BENNETT H. BROUGH thought that the facts brought forward by the reader in his interesting paper, clearly showed that in the matter of fuel, India would soon be independent of English supplies, and in view of the occurrence of coking coal to which he had drawn attention, this might eventually be the case in the matter of iron. This was a somewhat depressing outlook for the British iron and coal masters. As to the future of the Indian export trade, Professor Dunstan took, he thought, too optimistic a view. The exports, which did not exceed 9 per cent. of the output, were insignificant, and were hardly likely to increase, owing to Japanese and Australian competition. The Japanese and Australian coal more closely resembled true coal-measure coal than did the Indian coal of recent geological age. The Australian competition was especially noteworthy. Australian coal was even sent to Europe, and recent statistics showed that Germany last year received nearly twice as much coal from Australia as from the United States, notwithstanding the sensational newspaper notices of American competition in the German coal trade. He also disagreed with Professor Dunstan as to the suitability of mechanical coal cutters for use in India. These machines answered admirably in the United States, where labour costs were excessive. In India, however, where one-third of the coal-miners were women, the cost of labour was insignificant, and might almost be neglected. The coal cost 4½ times more to the consumer than it did at the mine, the difference being due to the cost of transport, storing, and the excessive profit of the middleman. It was in this direction that economy was desirable. A point that Professor Dunstan had not emphasised was the liability of certain Indian coals to spontaneous combustion. At Warora, for example, according to Mr. R. W. Clarke, in a recent paper read before the Institute of Mining Engineers, 70 per cent. of the coalfield had been lost by fire, and walled off. Should similar conditions obtain elsewhere, the cost of mining would be increased. On the whole, he thought it unlikely that Indian supplies would ever be drawn upon by other nations whose coal deposits were in process of depletion.

Mr. T. H. HOLLAND (Indian Geological Survey) disagreed with Mr. Brough's suggestion that the tendency to spontaneous combustion was more pronounced in India than elsewhere, and referred to the accidental causes of the few cases known. He denied also the probability of Australian competition being able at any future time to displace the Indian exports to the coast ports of the Indian Ocean. On the contrary, the increased strictures on coloured labour in Australia tends to insure the stability of the Indian coal industry, whilst further labour troubles in Europe will, except for special and restricted requirements, practically wipe out the small and gradually diminishing imports of European coals into India. The rise in the Indian coal industry followed most definitely the great colliers' strike of 1893, and any assistance given by Government agencies has been of microscopic value compared to the friendly offices of the labour leaders and trades' unions at home. Prosperity in Indian coal has come to stay; of that fact, the Government may assure themselves when considering the claims for further expenditure in railway facilities from the coalfields to the ports. He pointed out that the weak feature of Professor Dunstan's analyses arose from the past and present system of sampling the coal seams. With a non-expert agency for collecting specimens, the chances are about even for and against the analyses being representative, whilst assistance by interested experts must always be viewed with suspicion by those who know the natural weaknesses of human nature. The laminated character of the Gondwana coals accentuated the value of uniform sampling, and researches in future could be made of real value only by utilising an unprejudiced expert organisation such as we have in the Geological Survey of India, which, working in direct correspondence with an institution like the Imperial Institute, would yield results infinitely more valuable than the sum of the researches of the two institutions working independently. Analyses are of no value unless correlated with data as to the physical characters, proportion, quantity, and situation of the coal seams sampled. He pointed out that the reference to the anthracitic character of the Darjeeling coal would be, unless qualified, misleading. This coal possessed a higher percentage of fixed carbon than the Gondwana coals of the peninsula; but this was due, not to original superiority, but to secondary loss of the hydrocarbons, a change which naturally resulted in the proportionate increase of the other constituents, ash included. In acknowledging the great services Professor Dunstan had rendered to Indian economic mineralogy, the speaker suggested, as an additional subject for research, the possible occurrence of vanadium in the ashes of Indian coal. This metal, the wide distribution of which has only recently been noticed, has been found, amongst other unexpected places, in the ash of Gondwana coals in Australia and Argentina.

Mr. J. D. REES, C.I.E., questioned the propriety of introducing into Indian mining legislation principles found necessary in this country. As a member of the select committee of the Viceroy's council upon the Mining Bill, he had inspected the Bengal coal mines, and he found that there was hardly any need for any such regulations. The coolies working in those mines with their wives and children were among the happiest labouring people in the world. There was no danger from fire-damp, and accidents of any kind were extremely rare. Many natives of Bengal had been induced to discard agriculture for employment in collieries, and this was a great advantage to the country. After hearing the Chairman's speech in the House of Commons, two nights ago, he was inclined to think that Lord George Hamilton, as the head of the administrative machine of India, thought that they had gone quite as far as was wise, in imposing upon the people of India the superfluous services of an expensive civilisation. It seemed to him, that if the Bill had been postponed a little longer, and the inquiry as to the condition of the people had come on a little sooner, the measure might not have been passed. It would be interesting to know why there was no fire-damp in the coal mines of Bengal, whereas, in South Wales, miners went down in fear and trembling with their safety lamps. In Bengal the natives lit a fire below and cooked their food. When he was travelling in the Bengal coal district he discovered that the coolies were to some extent beginning to use coal in the immediate vicinity of the mines for firing and cooking. That was another proof that in India caste was no obstacle to inducing people to adopt any custom if they were let alone and not crushed by a cast-iron system. At present it was easy for coal mines to get labour, but unwise legislation might frighten people away. He had noticed on the diagrams that the coal from Glamorganshire, which had the highest calorific value of any coal in England, and the coal from Cherrapunjee, which had the highest calorific value of any coal in India, came from relatively the most rainy districts of their respective countries. Had that anything to do with the quality of the coal? He agreed with the previous speaker that the use of machinery for cutting coal would possibly not pay in India; he would let the people cut coal in their own way. On the other hand, he had observed in the goldfields in Mysore, where the air-drill was used for cutting exceedingly hard quartz, that the drills were used in a most skilful manner without the slightest difficulty by the natives. The more the people of India were let alone the more readily they would take to such occupations, and the more that diversity of occupation and improvement in the condition of the natives would be brought about which everyone desired.

Lieut.-General Sir RICHARD STRACHEY, G.C.S.I., F.R.S. said that the East Indian Railway during the year 1900 carried 5,000,000 tons of the 6,000,000 tons of coal produced in India during that year. It might, therefore, be said that practically the East Indian Railway was the great carrier of coal in India. It was quite certain that the future use of coal in India would depend upon the cost of transport and the improvement in transport. Roughly speaking, the cost of Bengal coal was about two rupees a ton, which was the present minimum charge for the carriage of coal over about 130 miles. Coal exported by sea would have to be carried about 150 miles, for which the charge would be about 2½ rupees per ton. To Umballa the distance would be about 900 miles, and the charge rather more than 14 rupees per ton. From that it would be seen to what extent the use of coal was likely to be possible generally. Whether or not it was possible to reduce the charge for carriage very considerably was a matter well worthy of consideration. He confessed his own opinion was that it could be reduced; and he thought that if the suggestion which Mr. Upcott made was carried out, and the East Indian Railway was allowed to manage its own business, the whole of the traffic arrangements would be greatly improved, and the cost of transport considerably reduced.

The CHAIRMAN said Professor Dunstan's valuable paper, together with the discussion, had particularly interested him, because it was his business every year to make a statement to the House of Commons with regard to the financial and material condition of India. The figures which influenced him most in preparing that estimate last year dealt with the development of the coal industry in India, and had been quoted that afternoon. He was anxious to be informed on such high authority whether or not that sudden development was a mere spurt or whether it was likely to be sustained in the future. After hearing Mr. Holland, who held a very responsible position in the Geological Survey of India and was a very high authority, and other gentlemen speak on the subject, he thought they must all go away with the opinion that the coal industry was for the future likely to develop, whether as rapidly as in the past remained to be seen. Putting on one side the question of export trade, he thought it was pretty clear that India could produce coal enough for its own consumption and of a quality which, at the price, was likely to keep all other coal out of the country. He thought there was no more important statement made by the reader of the paper than that concerned in the communication sent to him by a steam navigation company, namely, that during the sixty years' existence of the company they had always used Indian coal, the amount which they consumed in the previous year amounting to over a million tons. He thought that was most conclusive evidence, so far as the supply of Indian coal for navigation purposes was concerned. Certain suggestions had been made as to how the coal industry could be expanded, and mention had been made of the obstacles which might retard that expansion. He was glad that the proposals the reader of the paper made to the Indian Government were of a moderate character. Professor Dunstan had ventured to hope that the Government would establish a School of Mines, and had urged that attention should be given to the study and investigation of economic geology. He (the Chairman) was glad to say that Indian finance was very good. Notwithstanding all the complaints of poverty, India, for the last two or three years, had had surpluses which made the mouth of the Chancellor of the Exchequer in this country water, and it was their bounden duty, as these surpluses seemed likely to continue, to try and utilise them to the advantage of native industry and the development of the country's resources. Sir Richard Strachey had expressed the opinion that the cost of transport in India could be reduced. One method by which he suggested that reduction should be brought about was that the East Indian Railway Company should be allowed to do as it liked. He would not go into any of the controversies between the East Indian Company and the Government, beyond saying that Sir Richard Strachey was the veteran pioneer of many enterprises to which he had laid his hand, all of which had succeeded, and that he might congratulate himself on having been for so many years the chairman of probably one of the most powerful and best paying railway enterprises that the world had ever seen. At the same time, coal was very attractive; and once people got possession of a coalfield they liked to keep all other people off. The Indian Government was bound in the future to see that every reasonable railway access was given to the great coalfields of India, for the coal of which there was likely to be a large demand. He thought it was undoubted that the carrying capacities of the railways running into Calcutta had been overtaxed, and it was clear that their carrying power must for the future be considerably increased. The Indian Government had come to the conclusion that in their future railway policy it was their business to make the first charge upon capital for the proper equipment of all lines which were in running order rather than to scatter their capital in multiplying lines less efficiently equipped; and to that policy they would adhere. A conference had recently been held, not on the same subject, but somewhat germane to it, of railway engineers at Calcutta. He thought the unquestionable result of that conference would be that the locomotives in India for the future would be more powerful and heavier than they were now, capable of drawing greater loads. He could not help thinking, with regard to the conveyance of freight in India, that something might be learned from their American cousins on the other side of the water, who had contrived to reduce the cost of freight to a very low figure. He thought it should be their policy to diminish the cost of freight in India, because in proportion as the traffic was increased and developed the State could afford to make reductions in the charges hitherto imposed. He wished to say a word in connection with the legislation which had recently been passed dealing with the mining industry in India. He quite agreed with Mr. Rees's remarks that the Government must not attempt to apply European ideas or European standards, which might be in force in England, to another country where wholly different customs prevailed. All industrial legislation in England passed through two processes. It was violently opposed by the masters to whom it was applied, but as soon as it became law, so impressed were they with its superlative merits, that their one object was to apply it as rapidly as possible to every other competitor in other parts of the British Empire. So long as he was in the India Office that policy could not succeed. They were bound to take all reasonable precautions to see that due care was taken of the lives and limbs of those who were engaged in the mining industry at home; but at the same time it must be remembered that wholly different systems and customs were in force elsewhere. They should not in any way attempt to interfere with the natives who could work in the mines, in which they had been accustomed to work for generations past,—work which was congenial to them, and in no sense in excess of their strength. As to the recent Mining Act, it was a compromise. As originally introduced, he thought it went too far. It was modified in Lord Curzon's Council, and he had not heard that any objections had been raised to it since it had been in operation. In conclusion, he proposed a most hearty vote of thanks to Professor Dunstan for his valuable paper.

Professor DUNSTAN, in reply, said, with reference to the competition between Japanese and Australian coals on the one hand, and Indian coal on the other, that the question was fully dealt with in parts of the paper he had not had time to read. He had obtained a great deal of informatiom from the Calcutta firms on that subject. It was very largely a question of price, and the general opinion was that India ought to be able to hold most, if not all, of the Eastern trade. With regard to the question of coal-cutting, his impression was that, apart from cheap labour, the very great waste occasioned by cutting the coal by hand would be obviated by the use of machinery, whilst the output would be greatly increased. So far the natives had been extremely skilful in using such machinery. The liability to spontaneous combustion of Warora coal was well known to him, but it was a matter of comparative unimportance so far as Indian coal generally was concerned. With regard to Mr. Holland's remarks, the selection of the samples examined was undertaken by the Government of India. The matter was placed in the hands of colliery companies, who were requested by the Reporter on Economic Products to send representative samples of their seams. From what he had seen of more recent analyses of Indian coal it looked as though they were on the whole a fair average set of specimens. He would be only too pleased to co-operate directly with the Geological Survey in making a further examination of selected specimens of coal from different districts, and then no doubt they would be able to state the quality of different parts of the same seam. With reference to Darjeeling coal, the analysis he referred to was not his own, but that of Mr. Mallet, of the Geological Survey, who had found in one specimen as much as 80 per cent. of fixed carbon with as little as 10 per cent. of ash. He (Professor Dunstan) would be glad to receive further information on the subject, and to examine specimens of the coal in question which had been mentioned as deserving further enquiry. Mr. Holland had raised an interesting question respecting vanadium. He had not examined the ash of Indian coal for this element, but Professor Hartley, of Dublin, had recently been examining a large number of minerals for vanadium. If Indian coal had not been included, he should be ready to supply Professor Hartley with specimens for that purpose. Mr. Rees had referred to the Mines Act. He (Professor Dunstan) had merely drawn attention to the subject, and had expressed an opinion in favour of caution in making such regulations which he was glad to find the Chairman fully recognised in the very important pronouncement he had made on this matter. He could not offer a satisfactory explanation of the fact that Indian coal, as a rule, was free from fire-damp; but the chemical constituents of Indian coal were probably not the same as those of English and Welsh. The matter had never been investigated, and it would require a considerable amount of chemical and geological research to settle it. With regard to the rainfall of South Wales and Assam, and the heating power of their coal, he did not think there could be any real connection between the two facts.

Sir GEORGE BIRDWOOD, K.C.I.E., in moving a vote of thanks to the Chairman, said that before submitting the motion to the meeting, he would like to make a few remarks on the paper, with particular reference to the discussion on it. The paper, which was one of great ability and practical utility, was also an impressive illustration of the admirable work now being done under the indomitable administration of Sir Frederick Abel, both in the Scientific and Technical, and the Commercial Intelligence Departments of the Imperial Institute, the results of which were equally enjoyed by India, the Colonies, and the United Kingdom; and at a cost which was, at least to India, comparatively insignificant. Professor Wyndham Dunstan had during the past ten years examined a very large number of Indian natural products of all kinds in regular, current, casual, or speculative demand; and had not only determined their chemical constitution but reported on their commercial value, work which can nowhere be so advantageously ascertained as in London. The speaker expressed the hope that when the Imperial Institute was reorganised—if he might apply so serious a word to what would be merely a formal change—as a Government Department, under the direct responsibility of the Board of Trade, that the technical and scientific side of the Institute might be extended and developed still further, if only so far as India and the Colonies were concerned, whatever the Treasury might refuse to do for the United Kingdom in its drooping commercial competition with the Continent of Europe and the United States of America. He would offer no detailed criticism of the masterly paper that had been read to them; but he had been much struck by the discrepancy between the tabular chemical statement of the relative values of British and Indian coals, and the statements of their comparative practical values as reported by the engineers of Indian steamships, railways, and factories. It seemed desirable, therefore, that there should be a continuous chemical examination, extending over a series of years, of those Indian coals, which were constantly varying in character, in order that their average value might be more or less closely determined; otherwise these chemical statements became practically worthless, if not absolutely misleading and mischievous. As to what Mr. Upcott said of the desirability of inducing the natives of India to use coal for fuel, and, again, tea for drink; why on earth should they drink tea, when the rice water they habitually drink is so much better for them and so much cheaper? And why should they use coal when wood is so much better for their open fires, and so much pleasanter and, again, so much cheaper? The wood collected by one man or woman about Bombay villages in three hours would last a native family from four to seven days,. according to its size. He was delighted to hear of the improving prospects of Indian coal as the result of the constant strikes among our colliers at home. It was an object-lesson for both sides, the benefit of which would certainly not be thrown away on the keen-witted people of India. Passing now to his immediate duty, he would have wished, considering the high position and personal distinction of the Chairman, that the moving of the vote of thanks to his lordship had been entrusted to some one more worthy to submit it to that influential meeting. But he had one excuse for accepting the honour of acting as their spokesman on the occasion. Of the thirty years he had himself been employed at the India Office on special duties connected with the exploitation of Indian natural products at exhibitions, and in other ways, twelve had been served under Lord George Hamilton, and, therefore, with the exception of General Sir Richard Strachey, who they were all so pleased and proud to have among them that afternoon, he was probably better able than any one else to testify, not merely to the official, but to the spontaneous personal interest which his lordship had always taken in the economic well-being of India, and not only in the material, but in the moral advancement of the country. He (Sir G. Birdwood) was struck by this from the first year, 1873 or 1874, of his service under his lordship, who, from the very beginning had extended his confidence to him, and he could say, emphatically, that he never knew anyone more seriously and solicitously concerned in all that tended to promote the security and wealth, and health and happiness, and the pride and glory of the great historical people of India. Lord George Hamilton had already presided at lectures given before the Indian Section of the Society,—by Sir Charles Elliott in 1897, by Sir Mountstuart Elphinstone Grant Duff in 1898, and Mr. Athelstane Baines in 1900; and to-day, the occasion of the reading of Professor Wyndham Dunstan's invaluable and interesting paper, his lordship filled the chair for the fourth time in five years. He, therefore, most cordially moved the vote of thanks.

The vote of thanks was then carried unanimously.

Lieut.-Colonel R. GARDINER, R.E. (Chairman of the Madras Railway), writes:—

The details placed before his audience by Professor Dunstan satisfactorily established the position that India has within its limits a practically inexhaustible supply of coal of varying quality, but which, taken all round, is quite good enough for the generation of power for the various commercial purposes for which the provision of such power economically is a *sine quâ non.* A point, however, which must have impressed itself on the attention of those who examined closely the maps exhibited, and followed carefully the details regarding the various coalfields, was that the bulk of the supply is concentrated in Bengal and the Central Provinces, and this concentration when the immense area, practically all India, to be supplied therefrom is taken into account, brings out the importance of the transportation question as connected with this most interesting subject.

North of the readily followed dividing line formed by the Great Indian Peninsula and East Indian Railways running from Bombay to Allahabad, west and east across the centre of India, there is practically no coal of real commercial value as yet known, nor is it likely in view of the extensive geological knowledge of India which now exists that any will be discovered which would be of more than local interest. All Northern India, Western and Southern Bombay, and the Madras Presidency, have to look towards the coal deposits of Bengal and the Central Provinces for their indigenous supply of an article on which so much of their future industrial development depends, and the expansion of the coal industry so located and the provision of adequate lines of communication therewith becomes, therefore, a matter of the gravest interest to these vast and important portions of the Indian Empire.

The development of the Bengal coalfields both industrially and in the matter of transport, as the figures and other details given by the Professor satisfactorily demonstrated, is making satisfactory, it may even be said rapid, progress. The areas over which coal getting has actually commenced, are being rapidly covered by collieries with modern equipment, and the district is conveniently served by two important railways,—the East Indian Railway, and its younger and energetic rival, the Bengal Nagpur Railway. There is little doubt, that between these two railways, the Bengal fields will be well served; not so promptly, or so satisfactorily, as would be the case if greater liberty of action was accorded to the Indian railway companies, in the matter of foreseeing and providing in advance, for developments of traffic, but still discounting such disadvantages, it may safely be said they will in the end be well served by these two great companies.

Professor Dunstan has indicated the general directions in which the further opening up of the immense coal deposits, in the area bounded on the north and east by the East Indian Railway system, and on the west and south by the Bengal Nagpur Railway, might best be pursued, and I endorse most strongly his recommendation that increased attention be given to the practical geological investigation of the mineral resources of India.

In carrying out the surveys necessary for determining the best means of developing the still unexplored fields, practical geological and engineering investigations should go hand in hand, and a systematic exhaustive geological and engineering examination of the best routes to be adopted should be made, either directly by Government or through the agency of the railway companies directly interested in the development of the area concerned.

What is required at the outset, is comparatively inexpensive reconnaissance investigations, the engineers being assisted by practical geological experts. Expensive location surveys may well be deferred until the actual construction of any definite portion of line is about to be undertaken. A knowledge of the approximate routes to be followed by the new railway lines of the near future, and information regarding such geological details as would be collected during the preliminary surveys, and the Government might deem it desirable to publish, would be of the greatest service to private enterprise, and doubtless lead to the early opening up of new coalfields, and possibly of other mineral industries over this huge district, which is known to contain many valuable descriptions of mineral wealth.

As Professor Dunstan has pointed out in this valuable paper it is further most desirable, especially in the interests of Southern India, that the fields lying on the western side of the Central Provinces should have similar and early attention, and that either by a specially deputed Government staff or through the agency of the railways interested, the whole of the country from Itarsi on the north to the mouth of the Godavery on the south, shown on the Professor's map to be dotted over with coalfields, should be carefully reconnoitred by qualified engineers, assisted by practical geological experts. Coal would naturally be given the first place in such investigations, both on account of its importance for general purposes, and having in view its being a primary necessity for successful metallurgical operations; but at the same time, the other mineral resources of the districts traversed should be thoroughly examined. The country, speaking broadly, is known to be rich in minerals, and is probably waiting only for means of transport to give a start to their extensive development by private enterprise.

In his references to the railway communication question, which no one will fail to admit is a most important feature for consideration in connection with the subject of his paper, Professor Dunstan has briefly noticed the unsatisfactory state of the connections with Southern India.

An inspection of the railway map of India shows that between the Madras Presidency and the Central Province coalfields, from which it must apparently look, in the main, for its coal supply of the future, there is a vast belt of country bounded by the Great Indian Peninsula and Nizam's system of railways on the west, along the north and east by the Bengal Nagpur Railway, and on the south by the new East Coast Railway, absolutely devoid of cross communication, or practically, except along its boundaries, of any railways whatever. The length of this belt lying east and west is some 600 miles, and the width north and south varies, from some 400 miles at the west end, to 100 miles at the east, so that it covers the enormous area of not less than 150,000 square miles. I might enlarge here on the importance of providing this huge district with the security from famine that railways afford, with the administrative facilities that they supply, and the extent to which they foster and develop all the resources of the country which they traverse, but the point I desire specially to make now, in connection with the coal supply question, is the want of this cross communication. The absence of direct railway communication between the Madras Presidency and the rest of India other than Bombay has, I believe, had much to do with the isolation of the former and the comparative smallness of the intercourse and trade between that Presidency and India generally. This isolation has been partly broken down by the gradual opening out within the last few years of the railway east coast route between Calcutta and Madras, but Madras still wants and badly wants north and south communication with all Upper India *viâ* the Central Provinces.

This serious defect in the railway communications in general, and of the coal transport requirements in particular, of the Southern Presidency, could be remedied at once by two projects, to which I propose now to refer,—projects, both of which, are, I believe, capable of realisation in the immediate future, without inflicting practically any serious risk or liability on the finances of India, if only reasonable encouragement is given to private enterprise.

The first I will refer to, as the project has already taken a concrete form, is the proposed Raipur Vizianagram Railway. It would traverse the eastern part of the great railless (if I may coin the word) belt, to which I have referred, and by means of its proposed branch from Sointilla to Sonpur, which would doubtless be connected up with the Bengal Railway, *viâ* Sambalpur, would give an excellent railway connection with the coalfields of Bengal, and the Eastern Central Provinces.

The second project is for a great north and south railway to run from Itarsi through Nagpur down the Godavery Valley, and join up there with the East Coast Railway running into Madras. This new line would probably eventually extend still further to the northward through Jabalpur to Jhansi, and have in other directions connections with the Great Indian Peninsula Railway at Warora and with the Nizam's railway system at Warangal. Such a line would traverse completely the western part of the railless belt, and meet all the varied requirements of this district. Looked at from our present special standpoint it would afford facilities for the opening up of the Shahpur and Pench coalfields north of Nagpur, and the series of fields shown by Professor Dunstan to the south thereof, all of which would be on or in close proximity to its probable alignment, and bring them into close touch with the Madras Presidency.

The former project (the proposed Raipur Vizianagram Railway) has been already surveyed and detailed estimates of its cost prepared. Last year for a time it appeared in the Government list as a scheme to be taken up as soon as funds permitted. Financial considerations are believed, however, to have now relegated it to a back seat in the Government programme. Private enterprise has come forward and offered to carry through the scheme, but private enterprise in connection with Indian railways is not altogether plain sailing. Railways can only be built in India with Government permission, according to Government requirements, on an alignment approved by Government and subject to all sorts of Government rights, control, and general supervision. Under such circumstances private enterprise in connection with railways must always be a more or less joint stock concern with Government, and private enterprise cannot get along without active sympathy and support from Government such as one partner receives from another partner in any successful business. No amount of public declarations on the subject can adequately supply such a requirement. In return for the rights and advantages which Government secures, it may well give a reasonable modicum of assistance, and it may further, I submit, judiciously adjust the form of that assistance to suit the conditions of the case, and not bind itself by hard and fast red tape regulations which, however suitable for some cases, may be fatal in others.

That the Government terms and attitude towards private enterprise can be modified and rendered far more acceptable, without any practical increase in the financial responsibility involved, I fully believe, and am confident that if some desire to smooth difficulties and encourage such enterprise were shown, there would soon be an important expansion of it, to the great advantage of our Indian Empire in many respects.

Before leaving this part of the subject I would like to refer to a portion of the remarks with which Lord George Hamilton wound up the discussion, and which seem to me to emphasize the importance of the private enterprise question to which I have referred. His lordship informed the meeting that the Indian Government had come to the conclusion that as regards their future railway policy they must make the first charge upon the capital funds available, the proper equipment of all lines that are in running order rather than scatter the capital in multiplying lines less efficiently equipped. Clearly this is not a cheerful prospect for those advocating additions to the present railway system of India, unless private enterprise is really encouraged to step in to supplement the Government programme. The meeting of the requirements of the great revenue producing lines to enable them to pour still larger contributions into the Imperial treasury, is certainly most desirable, but this is capital outlay that is directly and immediately reproductive, and the provision of it should not be allowed to check, as there seems every reason to fear it will check, the railway development of the country generally and through it industrial progress of all kinds. As has been urged more than once, the treatment of the capital required for immediately reproductive works such as the expansion of a paying business, needs to be placed on a different footing from the provision of capital required for new projects which in the ordinary course must require a few years to develop.

My remarks on the aspects of the case touched on in the foregoing have taken up so much space that I must curtail what I have to say regarding the other points dealt with in this very interesting paper and the discussion which followed. The supply of labour for the collieries is not such an easy matter as it seemed to be considered by some of the speakers. The expansion of the coal industry in Bengal has been exceedingly rapid, and the consequent demand for a special kind of labour very great. That the demand will create a supply there is little doubt, but Indian labour, as indeed free labour all the world over, requires careful handling by people used to the customs of a country, and legislation in regard to it requires to move slowly and cautiously. No one will hesitate to approve of proper regulations for protecting the health and life of the workers provided you do not interfere unnecessarily with the old-established customs of the people. The remarks by Lord George Hamilton on this point, containing as they did a very clear indication of his views and policy, will, I feel assured, be received with approval by those associated with the industry in India.

The establishment of a School of Mines for India is clearly a move in the right direction, but too much must not be expected from it all at once. It must be borne in mind that the educated native is most unwilling to work with his hands, other than at clerical or similar employment, and this must be got over before you will get him to take to the training necessary to turn out good captains and submanagers of mines and eventually mine managers. Sir Richard Strachey, if he had had the time and cared to enlarge on the subject, could have told the meeting that in this matter, as in others, the East Indian Railway has not been behindhand. Some years back it placed its services at the disposal of Government for the training of engineering students from the Sibpur Engineering College at its Giridih mines, but those coming forward for the same were few in number, though the Bengal Government did what they could to foster the scheme.

A few words as regards railway freight rates. Indian railways have good reason for being fairly satisfied with the position they have attained to so far in the matter of their freight rates, the lowness of which compares favourably with those generally prevailing in any country, but I fully believe they can still go much lower, especially in connection with mineral traffic drawn by powerful engines in heavy trains with a high percentage of paying load such as can be got by the gradual elimination of all but well-designed modern rolling stock. When these changes have been carried through we shall see rates becoming customary that should have a marked effect on the coal-using industries situated at long distances from the coal-producing centres. For the coal export trade improved facilities will doubtless be given at Calcutta and possibly elsewhere, but though I have always held that Bengal coal should rank high in outside markets east of Suez, I rather question whether any very great expansion over the figures of the present (so-called) export trade can be looked for, partly, as I believe, that before long cheaper inland transportation rates will deprive this trade, of a portion at any rate, of the present sea-borne supplies taken at some of the Indian ports, and partly because we cannot shut our eyes to the increased competition it is likely to have to encounter as other sources of supply are opened up in the further East.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 19th, 1902; Professor SILVANUS P. THOMPSON, D.Sc., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Acheson, Edward Goodrich, International Acheson Graphite Co., Niagara Falls, New York, U.S.A.
Bertram, John Ross, 101, Clive-street, Calcutta, India.
Cooper, Richard Powell, D.L., Shenstone Court, Lichfield, and Ashlyns Hall, Berkhamsted.
Da Costa, José Simão, P.O. Box 208, Parà, Brazil, South America.
Perrin, Henry, 23, Holland-villas-road, W.
Plowden, Colonel Francis Hugh, care of Messrs. King, King, and Co., Bombay, India.

The following members were balloted for, and duly elected members of the Society:—

Bell, Colonel A. W. C., West End-house, Witney, Oxon.
Gilchrist, William, Cringletie, Peebles, Scotland.
Shingleton, Albert James, 8, Argyll-mansions, West Kensington, W.
Smith, John Ciceri, 61, Hatton-garden, E.C.
Thomson, H. Arthur, A.I.E.E., 45, North Bridge-street, Airdrie, Scotland.

The paper read was—

ELECTRIC TRACTION: LONDON'S TUBES, TRAMS, AND TRAINS, 1902.

By J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E.

Within the past twelve months two pressing problems regarding rapid transit have come prominently before the public mind, taking front rank among the immediate questions of the day. One of these is how the "tangle of locomotion" in the Metropolis is to be straightened out and relieved—the other is the question of a greatly extended use of electricity in locomotion.

The intimate relation between these subjects is now universally recognised, for in one it is seen we have the solution of the other. "Our bane and antidote are both before us," and I hope that at the end my hearers may be convinced that while the trouble in London is, like Cato's dagger, threatening an end to the possibility of motion, the more recent developments of science show that the Metropolis need "never die" of the threatened congestion. And thus the philosophy of Plato may serve to illustrate how pregnant is the present danger, and how complete is the remedy which now seems ready to our hands.

It is needless on the present occasion to dwell on the recent marvellously rapid development of the uses of electricity. We see it is not only supplying light, heat, and power throughout the whole world, but we witness its growth as an agent in traction, not merely upon the solid earth, but even in and through the air, and on the waters or under the water. My rôle to-night is not to give an exhaustive picture of the manifold uses of that subtle force. It is confined to the less extensive, though, at this moment, hardly less important task of reviewing the past progress of electric traction; of depicting its present position, more especially as regards London, with perhaps a glance forward to its future, its ultimate development.

It is now nearly twenty years since, at the request of the Royal Scottish Society of Arts, I prepared and read a paper on tramway traction. At that time "cable" had just come into vogue in America, and, as it was at that time far in advance of any other form of mechanical power on surface tramways, I was glad to be able then to give the first public description and advocacy of such a method of traction in this country. But the dominance of the cable was short-lived, and in anticipation, perhaps, of what was in store, I was led to express the view that we should do well to "preserve an open mind for future developments." At the time, the only practical example of electric traction in this country was the Portrush Railway, which, with its third rail conductor laid on a level with the track-rails, served in no sense to commend electricity for surface tramways. Its only value, then or now, lay in showing how the electric current could be cheaply generated by water power, and transmitted from a distance, and that lesson in the production of electricity is as yet only partially learned.

Since the date of my Edinburgh paper nearly the whole of that period has been devoted by me to the study of the practical application of electric power to tramway traction at home and abroad, and ten years ago I was engaged to prepare the plans, and later to carry into completion at Bristol the construction and equipment of the first electric tramway in Great Britain built under the existing stringent regulations of the Board of Trade.

With these few preliminary observations I will now proceed to consider as briefly and as succinctly as lies in my power the many points that arise for discussion under the title of this paper.

THE PAST.

In the rush of advancement now being experienced, it appears hardly necessary to burden the "past" part of our story with many statistics. But a few figures may be given that will serve as a basis from which to reckon the extent of the advances made, as well as to show how meagre and insufficient these advances have really been in this country. Judged by results up to this day, the Tramways Act of 1870 might truthfully have had as a preamble the words, "Whereas it is desirable to discourage the construction of Tramways in this country." Such have been the burdens and hindrances laid by that Act upon promoters of tramway enterprise, that the record of tramways in the United Kingdom showed in 1890 only about 160 tramways in existence, covering (I put it roughly in round figures) something under 1,000 miles of route. A few sections of these tramways were worked by cables, such as Brixton, Birmingham, Edinburgh, and Highgate Hill. Locomotives "of strange device" were in use here and there, as in Birmingham, Leeds, Sheffield, Stockton-on-Tees, Dundee, &c., while all the rest of the lines in the kingdom used that good old time-honoured motor, the horse. The division of the lines was in 1890 somewhat in this proportion:—

	Route miles.
In London and its immediate suburbs	120
Elsewhere in England	640
In Scotland	85
In Ireland	110

The passengers then carried numbered a million and a half per day, about one third of these—188 millions per annum—being carried within the London district. This latter fact may be dwelt upon a little. Owing to obstacles put in the way—in the same spirit as the early railways were in many cases compelled to put their stations as far away from towns as possible—a determination seems to have been arrived at, that no "base unmannerly corse" of a tramway car should be allowed to "come between the wind and the nobility" of London's most crowded, and therefore most necessitous thoroughfares! Yet, in spite of this stupid blunder, of which we reap the fruits to-day, we gather from the returns, that with about one-eighth of the mileage in the kingdom, suburban London supplied about one-third of the number of passengers. Notwithstanding this notable encouragement to provide more of such a manifestly popular means of urban travel, we see to-day in London on one side an obvious necessity for the speedy improvement of the means of locomotion to, in, and through the metropolitan area, and on the other side the most bitter opposition on the part of nearly every man in power, and an endeavour of local authorities to hamper and obstruct attempts to grapple boldly with the vast and pressing problem.

But to return. In 1890 there were no electric tramways in Great Britain. The Portrush and the Bessbrook and Newry lines were not "tramways" in any sense, although serving local needs, and the City and the South London—the pioneer "tube," opened in 1890—was then and still remains a remarkably bold effort to open up a better prospect for London locomotion. Twelve years after this line was opened we find that, despite the success of this method of constructing an underground line, and its marked usefulness in respect of the carriage of passengers, all that has been accomplished is an extension of this serviceable line, the construction of the Waterloo and City line, and north of the Thames one other electric underground railway (the "Twopenny Tube") has actually been successful in overcoming obstacles and obstructions and getting itself constructed.

Of course, the first electric tramway in Great Britain was not in London—it seems to have been too much to expect the Metropolis to be ahead in anything so desirable—and the "object lesson" had to be provided elsewhere. Previous to the issue of the Board of Trade regulations, two successful efforts to work a tramway by the overhead trolley system had indeed been made in England. In 1893 the Roundhay line in Leeds was put into tentative operation, and in the same year the conversion of the South Staffordshire steam lines, serving a somewhat scattered district, was opened for traffic. But the first electric tramway which followed the issue of the Board of Trade regulations in 1894, and which was established in conformity therewith, was, as I have said, in Bristol. This line, for the conception and construction of which I was mainly responsible, was opened in October, 1895. It was an instant success, and has been worked without stoppage or accident in the six years intervening.

This first example of an electric tramway in a city formed a standard for future guidance. It proved conclusively that a district could be opened up under electric traction, which, with only horse power available, must, owing to its gradients, have remained without a tramway. It proved further that lines so radiating from a busy centre, passing through and to scantily-populated districts, are electrically and commercially successful—of which some people had doubts—and that those sparsely-inhabited districts immediately began to grow in population, and in rateable value and prosperity. So unequivocal was the conversion of the citizens of Bristol, from doubt or opposition to enthusiastic approval, that the Bristol Tramway Company immediately proceeded not only to convert all its existing lines, but to extend its mileage in various directions under electric traction, and the fine power-house lately finished at St. Philip's Bridge contains an up-to-date installation capable of developing 7,000 horse-power, practically the whole of which is already in demand to meet the continuous growth of traffic.

I need not pursue the trend of my story in this direction further than to point to the two cases (1) of Dublin, where the first electric line was constructed and opened by me in 1896, and (2) the Tee-side lines opened in 1898, as providing significant confirmation of the points indicated.

In Dublin, where a furious opposition had been encountered, the United Company there acquired from my company this pioneer Dublin, Kingstown, and Dalkey line soon after its inauguration, and immediately proceeded to convert the whole of its extensive horse tramways to the overhead trolley system. In Stockton-on-Tees and Middlesbrough two detached lines, of different gauges, and worked by steam and horses respectively, were unprofitably carrying only one million of passengers in a year. A thorough electric system was constructed traversing both boroughs, and also the intermediate borough of Thornaby-on-Tees, and in the first year the passengers we carried numbered eight millions, a phenomenal increase having regard to the district. And here the element of progress in buildings, &c., was also seen in the gradual disappearance of "the Wilderness"—a bit of waste land between Thornaby and Middlesbrough—over which streets and houses are springing up in large numbers. All round Tee-side the cry to our Company now is, when are you to extend the electric tramway to the surrounding suburbs and townships? and to comply with this call we are contemplating important extensions.

An important event in the development of electric traction was the passing of the Light Railways Act in 1895. When that Act came into operation the use of electricity for traction in this country had not advanced very far; and this was seen to affect the applications made under the Act, for in the first eighteen months of its operation, the projects submitted to the Commissioners were:—

For steam locomotion	53, of 626 miles.
For electric traction......	32, of 324 miles.

While in a like period of time ending in December, 1900, the figures were;—

For steam	21, of 298 miles.
For electricity	63, of 474 miles.

For the year already passed in the new century the applications are found to be:—

For steam	9, of 59¼ miles.
For electricity	54, of 595 miles.

In the general tramway advance in this country up to the end of 1900, the increase from 1890 was, in mileage, about 15 per cent. only. But the passengers had increased from 526 to 1,000 millions in 1900, and they further increased to 1,198 millions in the year ended June, 1901, the metropolitan area maintaining, as before, the proportion of about one-third of the total. But our concern here is with electric tramways. As has been seen, one-half of the decennium had practically passed before such tramways were brought into operation. The fact is reflected in the figures up to 1895 and up to 1900. The first five years added only about 34 miles to the total, and the passengers reached 650 millions per annum. But the second lustrum added about 200 miles, and the passengers grew to over 1,000 millions per annum. The latter increase is far in excess of the ratio of mileage, and may be accepted as demonstrating the influence of more rapid transit and superior accommodation in developing passenger traffic.

A few suggestions and valuable figures are found in the Board of Trade returns for the first official year in the new century—that is, for the year ending 30th June last, the figures for which have just been issued. They show a total open mileage of 1,305 miles, while the passengers numbered 1,198,226,758. The number of undertakings then had reached 213, of which 99, extending to 689 miles, were under local authorities' control, and 114, of 615 miles, were in the hands of companies.

It is a misfortune of statistics that the Board of Trade returns take no account of the number of electric motor cars; but the following figures are significant. The year 1898, it may be stated, showed maximum number of horses and locomotive engines:—

	No. of Cars.	No. of Horses.	No. of Locomotives.
1898	5,335	38,777	592
1901	7,184	34,422	527
	Increase.. 1,840	Decrease 4,353	Decrease 62

The number of cars in operation increased by 34 per cent., while the horses and steam engines were each decreased 11 per cent. This comparison shows the growth of electric haulage.

The Present.

In the general survey of the position which electric traction has reached to-day, the first, I think most prominent point, is the utterly tangled and belated condition of tramway legislation.

I have entitled this paper "Tubes, Trams, and Trains," and when we look at the condition of the law and parliamentary procedure, we find that under each branch different laws and practices exist. If we propose to construct a tramway the General Tramways' Act of 1870, with its purchase clause 43 and incidentally, Standing Order 22, block our way. Light railways are under a different law, but with difficulties peculiarly their own. A railway stands on a still different footing, and it possesses the distinct privilege of coming before Parliament on its merits, an advantage hitherto denied to tramway undertakings. And here we encounter a curious anomaly. It has been specially recommended by the Joint Committee of both Houses which sat last year, that the London problem should be largely met by means of underground lines within the more congested parts of "London and its immediate suburbs," joined up for purposes of interchange of traffic with electric surface tramways, &c., in the suburban districts. To do this under existing arrangements, the surface lines must be promoted as tramways, while the tunnels, although designed to form integral portions of the through service, must be promoted as railways. For the one, the two-thirds consent of the various local authorities concerned, must be obtained by previous negotiation, or the project will fail under the Standing Orders, while a railway, whether it be "tube" or "shallow tunnel," comes at once into Court on its merits, and cannot be wrecked on the threshold by interested opponents or obstructive municipalities. This difference between a tramway and a railway is clearly indicated in the words of Lord Morley, Chairman of Committees in the House of Lords, when he says it is not right that anybody should be able to prevent a scheme from coming before Parliament. He further shows how unfairly the double veto of the road and local authorities bears on promoters, and how contrary to the public interest it is that local authorities should be able to exact onerous conditions as the price of their consent. I join with everyone who has recently spoken or written on the subject, that one of the greatest obstacles to electric progress in Great Britain has been the discouragement presented on the one hand to scientific and manufacturing skill, and on the other hand to financial enterprise, by the shackles and hindrances which legislation has imposed.

It has been recently urged that the Tramways' Act of 1870 had in view horse traction alone, and that it was also anticipated that no tramway would traverse the territory of more than one municipal or local authority. This is probably true; but the statement makes the plea all the stronger for an alteration in the law.

The Tramways' Act of 1870 to-day makes the promotion of electric tramways most arduous, and indeed, in some respects, impossible, and even my own various, and to some extent, successful labours in breaking down the twenty-one years purchase clause, and in struggling against the demands of Standing Order No. 22, afford no argument in support of the existing conditions. As is well known, I have had to encounter negotiations with a full score of local authorities in the promotion of one tramway Bill. Objections reasonable and unreasonable, conditions onerous and even prohibitive, have had to be fought out, not in the fair and open tribunal of a "Parliamentary Committee," but in local caucuses and conclaves, where the pressure of the knowledge that one hostile authority might wreck the Bill, has given boldness to unconscionable demands for conditions. And the bitter irony of the thing is that even although we may with hard fighting and heavy expenditure pass portions of a scheme on Standing Orders, there has been no precedent yet created under which a Committee of Parliament has sanctioned the removal of the general veto possessed by such authority, or has in the teeth of the opposition of even one local authority, passed the preamble, and allowed the Bill to proceed. This is, indeed, the very anarchy of legislation.

There has been evidence of some gradual change of public feeling, as electric lines have been opened up to traffic and the real benefits of the service have become manifest. But the irreconcilable opponent of tramways in any shape still exists, and the hardness of heart of local authorities in striving to impose impossible conditions is as yet little abated. Small wonder is it that Great Britain lags behind the world in electric invention and general electric development, and that even when we do succeed in getting a lighting or a tramway project authorised, we have had perforce to go to the United States for much of the plant and machinery special to such undertakings.

Yet, although I speak thus, I am able to claim a fair record of work accomplished in this backward island of ours. It is something to have been instrumental in awakening London to a knowledge of what electric traction can accomplish. It is something to have shown that to-day, upon sixteen miles only of London United Electric Tramways, it is possible to carry a record of passengers equal to more than a twentieth part of the total of passengers carried on the thousand miles of tramways in Great Britain, as recently as 1895. This is a pregnant fact, worthy the attention of anyone who seeks to disparage the capacity of electric cars such as those on our system, or perhaps even ventures to suggest that a service of other vehicles, such as 'buses or, as now proposed, steam 'buses, might, after all, give double or more the accommodation to passengers over the same route as our electric tramways. It is overlooked by the ingenious writers who are hoping for great things from some new steam omnibus that while, as they say, steam tram-cars have a record of 20 years' failure behind them, steam omnibuses have a record of about 70 years of failure, as everyone familiar with the endeavours of Mr. Hancock and Mr. Scott Russell well know. I may commend to the attention of all such people the excellent argument of Mr. St. John Hankin in a letter to the *Daily Chronicle* (an argument which I also have often suggested) that the streets of London are congested because we have adhered to horse vehicles and 'buses. "It is the absence of tramways which crowd the London streets," says the writer—a somewhat Hibernian expression, but undeniably true.

We have seen that in 1895 the total number of passengers carried over the tramways of Great Britain and Ireland—about 1,150 miles of line—amounted to 650 millions, about one-third of these being in the metropolitan area. On our sixteen miles of electric tramways in West London we are to-day carrying passengers whose total, when a full year of electric working has been completed, will not fall short of 35 million, being over 2 million per annum per route mile against a total for Great Britain, seven years ago, of under 600,000 per mile.

Notwithstanding this conspicuous success, first, in overcoming the inertia as well as the more active opposition of a multitude of local authorities, and next, in demonstrating to all London the magnificent service that a well-organised electric tramway can give to the public, there can be no complete solution of the great London problem—there can be no finality seen—so long as the existing legislative and parliamentary conditions exist, and it is satisfactory to know that the Government has been so far aroused to the need for some action, that a Special Departmental Committee of seven able and expert gentlemen has been appointed to report on the whole subject.

In the Act granted by Parliament to the London United Tramways, Limited, in 1898, a clause was inserted by the Treasury giving certain powers to the authorities of Kew and Greenwich observatories, which for a time threatened to be a very serious obstacle, indeed, to every electric proposition within the metropolitan area. From early 1899 till the latter part of 1900, negotiations, experiments, &c., were carried on, the while that the construction of the London United Tramways system was delayed. Even in 1900 no substantial progress towards a settlement of the claims of these observatories had been made, and pending a settlement the whole question of electric tramways in London had come to a deadlock. It is customary to rail at the Metropolitan and the Metropolitan District Railways for their delay in proceeding to the electrification of their lines. But, I have no hesitation in saying that until the directors of the London United Tramways took the definite step in April, 1901, of approaching the Treasury on the observatory question, no real progress with the electrification of the earlier underground railways could have been made. The South London, the Waterloo and City, and the Central London railways had obtained their powers, or were in operation before this claim arose, or they, too, would have had their progress arrested, while even as going concerns they would have been liable to ridiculous interference if Kew and Greenwich had had their own way. It fell upon the London United Tramways Company to provide the cash in consideration of which this obstacle was removed. Although the sacrifice was great, the case was so clamant that the London United Tramways Company, without assistance from the various other electric traction concerns in London, undertook the obligation to pay a sum of £10,000, and thereby brushed aside the difficulty and earned the thanks of every electric tube, tramway, or railway promoter, director and shareholder within the area of London.

Another point of Government interference already referred to, which threatens to give great trouble to electric undertakings, whether for light, power, or traction, throughout the whole kingdom, is the determination of the Postmaster-General to introduce clauses, alleged to be required for the protection of telegraph and telephone wires, which would place in the hands of the Post Office the power of controlling every electric undertaking in the country. We have had to assent to these clauses, although of opinion that they are not necessary for the Post Office, while certainly harmful to tramway enterprise. It seems to be an attempt to throw on companies and corporations an unreasonable burden, which properly belongs to the department itself. I am the more decided in making this statement because in the observatory case the reliance we were led to place on the Board of Trade as standing between us and the observatory authorities, completely failed us, and after a year of negotiation the Board of Trade, as possessing no judicial powers, remained practically helpless.

Attention may be drawn to another sign of danger to electric traction, as regards underground lines, whether "tubes" sunk at varying depths, or "shallow railways" under the streets, parks, &c. At a meeting of the Auctioneers' Institute of the United Kingdom, held on 4th December last, Mr. G. M. Freeman, K.C., read a paper on "The Problem of the Tubes," dealing principally with the landowners' position in the matter. The learned counsel pointed out that Parliament had dealt with such tunnels under streets as if the soil under the street belonged to the local road authority, while in point of fact only such a depth is vested in the road authority as is needful to enable sewers, &c., to be constructed, the road to be kept in repair, &c., while all the soil below belongs to the adjoining landowners. After showing how the further rights of landowners are in such cases declared as unaltered under the Lands Clauses Acts, Mr. Freeman proceeded to say, "The only question in this case is—what is the best way of enforcing this claim" of the adjoining landowner? There is here hung out a danger signal to which promoters of underground lines would do well to take heed. One illustration may be given. Mr. Freeman says, "In modern times, owing to the great value of the surface, it is often customary to sink double basements extending under the footways, and, in other cases, to run connecting passages under the street between two buildings of the same owners on either side of the street. The tube railways are carried at various levels, and it might be that their coustruction would render it impossible hereafter to carry out double basements or subways, as could have previously been done. Here is a clear head of damage, but its amount depends on the date when these works will be required."

Rights, especially in land, cannot be pushed to extremes, and if a hypothetical case, such as was hinted at, as "perhaps I may wish to deepen my cellar some day," or even, "perhaps I may buy the opposite house, and may wish to make a subway to it," is to be pushed, the case of London underground communications will be made all the harder."

It is of value to to find that Mr. Freeman, although pointing out certain directions in which claims for compensation might be made, opposed the idea of one of the speakers, that the limit of distance within which a *locus standi* should be given should be extended to 350 yards, expressing his view that a limit of 100 yards would not be inadequate. "They could not have an illimitable zone." For this assurance, much thanks!

THE NEAR FUTURE.

Having thus glanced at the earlier history of electric traction in London, and indicated some of the difficulties which have hampered progress in the past, and which still threaten us in the future, I shall now endeavour to describe the outlook in the immediate future.

Of electric tramways in London, the leading place is occupied by the operations of the "London United." It is a matter of common knowledge that the London County Council obtained the control of the tramways in South London six years ago—in 1896—and that the actual progress there is limited, so far as electricity is concerned, to a decision to begin this month to convert a portion of the existing horse-lines to underground conduit. The Middlesex County Council is also awakening to a sense that some energy is called for by the public, and has abandoned its obstructive tactics, so that it will in the future work in harmony with the enterprise in which the development of greater London is so largely concerned.

As regards "tube" electric railways, the position in London shows:—

Lines in Operation.

The City and South London Railway, opened in 1890.
Waterloo and City Railway, opened in 1898.
Central London Railway, opened in 1900.

Lines under Construction.

Waterloo and Baker-street Railway.
Great Northern and City Railway.

The last named differs from most of the other "tube" lines, in so far that it is constructed with tunnels of 16-feet diameter, so as to allow ordinary railway stock to run over its rails.

Lines Authorised.

1. Brompton and Piccadilly-circus Railway.
2. Charing-cross, Euston and Hampstead Railway.
3. City and Brixton Railway.
4. Great Northern and Strand Railway.
5. North-West London Railway.

The above enumeration gives the following figures:—

	Route miles.
In operation	$15\frac{3}{4}$
Authorised and under construction	$36\frac{1}{2}$
	$52\frac{1}{4}$

When the stoppage to further legislation was made in 1901, in order that an investigation should be made by a Joint Committee of the two Houses of Parliament into the whole question, proposals covering a route mileage of $57\frac{1}{2}$ miles had been placed before Parliament. Some of these will not be heard of again, while to the list may be added several new and important schemes.

The appointment of the Joint Committee, and the postponement of all legislation on tube railways in London in 1901 as the consequence of its appointment, divides the history of the subject in a very marked manner. It was a strong Committee, sitting under the chairmanship of Lord Windsor, and as the result of their deliberations they laid down one or two valuable principles, regarding which I shall have a few words to say.

The interregnum was filled up as regards electric progress by the negotiations between the Metropolitan and the Metropolitan District Railway Companies with reference to the "electrification" of their lines. The antagonism between these companies appears to survive to this day, so much so that even in presence of a common enemy in the shape of the "tube" railways, unity of action or unity of interest has not been achieved, and even since the Board of Trade arbitrator gave his decision in favour of the District Railway's proposals, we have failed to see on the part of either company that desire for unity of purpose by which alone the best results for the public or the companies can be obtained. Mention need only be made of the determination of each company to have its own generating station, as an illustration, for here the Boards are going directly in the teeth of all experience which points to centralisation as an essential element to economy and efficiency.

Of the Bills to be brought before Parliament in the current Session, I naturally place in the front the London United Electric Railways, in connection with which Mr. S. G. Fraser and myself are acting as joint engineers, the undertaking being promoted in direct affiliation with the existing London United Electric Tramways. The report of last year's Joint Committee contains the following important recommendation:—"Underground railways in London and its immediate suburbs. . . from the termini of which passengers could for the present proceed by electric surface tramways . . . appear to be the best mode of dealing with the present traffic, and the probable requirements of an increasing population."

What is foreshadowed in these words is crystallised into form in the systems I now proceed to describe, which have the additional advantage in the public interest, that the systems both underground and on the surface, will be under one administration, and operated so as to secure to the public the full benefit of mutual interchange of traffic, correspondence of services, and minimum and uniform fares.

Let me briefly recapitulate the full details of the London United system now working, under construction, and proposed. I have prepared a map, showing all the existing and proposed tramways, as well as other railways, &c., in the same district. The following is a short tabular statement:—

	Miles.
Electric tramways in operation	16
,, ,, now under construction ..	42
,, ,, extensions proposed ..	15
,, ,, as light railways do. ..	8½
,, (tube) railways do. ..	13
Total	24½

The lines in operation have served the double purpose of affording a great public convenience over a large and interesting suburban territory, and opening the eyes of London to the great possibilities, in economy, efficiency, speed and comfort, of a properly organised electric service.

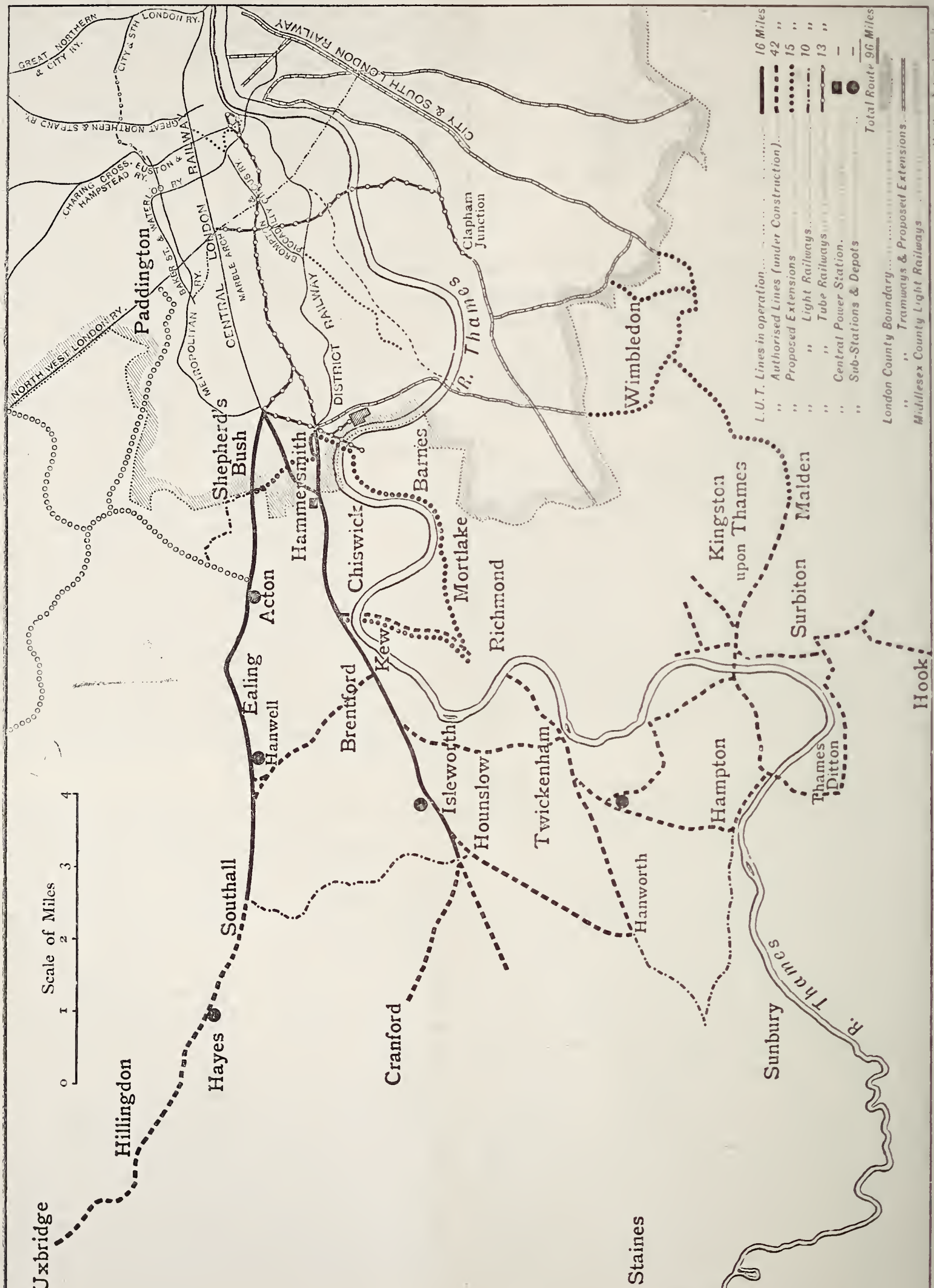
The lines under construction, amounting to 42 miles of route, are seen by the map to cover with what, in Mr. Balfour's phrase, I may describe as "radiating roadways," a large extent of the western and south-western suburban district, embracing such far distant places as Uxbridge, and Kingston-on-Thames, and all that great holiday and residential district of suburban London along the picturesque Thames valley indicated by such names as Twickenham, Teddington, Hampton Court, Richmond, Isleworth, Surbiton, and Thames Ditton.

The proposed extensions of the surface lines for which authority is now sought, comprise 23½ miles of electric tramways and light railways. The sections of light railway show first a line from Hanworth to Kempton-park, and returning to Hampton, both termini fitting to and to be operated with the authorised tramway lines now in course of construction. The cross line from Hounslow to Southall joins at the latter place the light railway already existing there, now operated as an integral part of the system between that point and Shepherd's-bush. From Malden to Wimbledon a through route connection is secured, which, branching in three directions, opens up an important district, and touches at each terminus the frontier line of the London County. The line from Kew to Richmond is a proposal to electrically convert the present horse line so as to form an integral part of our main system, and with this is now proposed, and locally sanctioned, the important route from Richmond by Mortlake and Barnes to Hammersmith. We proposed also a number of important extensions in and around Hammersmith, but for most of these the consent of the London County Council has been refused. They were routes actually scheduled by the County Council for its own lines, but so naturally falling in with our lines that the Borough Council of Hammersmith has preferred to assent to our plans, while refusing assent to those of the County Council.

Here is another example of the tangle of tramway legislation. The lines are admittedly required, we have the assent of the local authority to make them, but the County Council, while in the position of a rival promotor, has the power as the other authority to step in and, by refusing assent, prevent us from presenting our case on its merits to Parliament. Surely if ever a case arose for the suspension of Standing Order, No. 22, here is one, to which is Lord Morley's remark aptly applied. Far different indeed is the condition of affairs in some of the other districts affected by our proposals of this year. With Barnes and Wimbledon and Richmond for instance, we have concluded agreements, where in consideration of large outlays for street improvements, we have got periods of 50 and 25 years respectively, with power of purchase in the two first cases on going concern terms. These cases illustrate the value to the public of enabling a company to undertake great permanent improvements which could not possibly have been undertaken if burdened with Clause 43 of the Tramway Act, 1870.

Combined Surface and Tunnel System.

I now come to a great advance in combined railway and tramway operation involved in the "tube railway" proposals of the London United Companies. Before I go further here I may take notice of the shallow railways operated in Buda Pesth and Paris, and now being constructed in New York, Boston, and some other places. Briefly, I think it can be said that such construction is more suitable for countries where the roads are free from competing claims, or in lands where an Imperial or despotic hand may override all objections. In the Boston case we have brought to view a railway made immediately under the roadway, and so lit up by making use of every possible opening, or by the generous use of electric light, that the ordinary single electric car runs into the tunnel from the open, and the "shallow railway" is in every respect merely a continuation of the tramway outside, thus saving the public the inconvenience of changing carriages.



Walker & Cockerell

There is in British tramway practice a difficulty which does not present itself to the American or the Continental engineer; I need hardly say that I refer to the practical universality of outside seats on our tramway cars. Despite the austerity of our climate on occasions, there is strong public desire for outside travel, such as seems not to prevail anywhere else in the world. Hence we have always had a hard and fast line of demarcation between a railway carriage and a tram car, while in nomenclature the two have been one in America. But, except under special circumstances, it would be impracticable to adapt a shallow tunnel to accommodate top-seat cars. In the letter to the *Daily Chronicle*, already quoted, this desire for open-air travel was used as an argument against "tubes" altogether, and in favour of electric tramways all over. To that our company could certainly have no objection. But if London must have its tramways in tube, we are prepared to supply them.

We must not overlook the noteworthy fact, that in the "Greathead Shield" British engineering has presented to the world a means so admirably suited for the economic, safe, and rapid construction of "tube railways," that it would seem only to be courting opposition and expense not to avail ourselves of that useful invention, and follow out the familiar pattern. What we have therefore set before our minds, in designing the London United Electric Railway, is to make full use of this important method of construction, while, at the same time, reducing to a minimum the inconvenience at the stations, wtth special arrangements in the form of moveable platforms, ventilation, &c., so as to attract the public by lessening the objections more or less inseparable from an underground line. As I have hinted, the interchange of traffic and minimum fares will be made special features, carrying out even more fully than the Joint Committee suggested the facilities for through travel from the centre of London to its vast western and south-western suburbs,

Of course, there will be communications opened by means of subways with all the other "tube" railways, whose course may be touched or crossed, so that the very widest facility will be provided for expeditiously traversing the whole of the suburban and metropolitan areas, with a maximum of ease and a minimum of outlay on the part of the passenger.

The cars proposed to be run on this underground line will be of special design and construction, calculated to remove altogether some of the risks which have, in some few instances, developed themselves on lines already existing. It is impossible, of course, now to set forth in detail the various improvements to be carried out in this and other respects.

It is believed that from the principles of construction, installation and operation, the same success in conducting the traffic will be attained as has been achieved on the electric surface tramways now under the same administration and management.

The routes to be followed by the London United Electric Railways are seen from the diagram. They consist of two principal lines, making in all some 13 route miles :—

(1) The East and West Railway, extending from Charing-cross to Hammersmith, where an extended loop will embrace both Shepherd's-bush and the Hammersmith-broadway, with a tunnel under the River to the Richmond Mortlake Tramway Terminus at Barnes.

(2) A north and south line, running from the Marble-arch, *viâ* Sloane-street and Battersea-park, to Clapham-junction.

The importance of these railways will be seen, as providing full interchange of traffic east, west, north and south, from Cricklewood to Clapham, and from Charing-cross to Uxbridge, Hounslow, Kingston-on-Thames, Hampton-court, and the whole of the Thames Valley. The second line proceeds southwards and south-westwards, with stations at Chelsea-bridge-road, Battersea, Queen's-road, and Lavender-hill, terminating near Clapham-junction, with a station, as at Barnes, so near the surface as to be there practically a "shallow railway." The importance of this project will be seen when it is stated that the cost of the works, lines, and stations (apart from power-house and equipment) is estimated at some $3\frac{3}{4}$ millions sterling, the total estimate including acquisition of properties, stations, &c., being £5,413,250. It is perhaps interesting here to state that while last year the Parliamentary powers obtained involved an expenditure of £40,000,000 on tramways in the United Kingdom, a conservative estimate of the capital represented by tubes, trams, and trains in and about London alone will represent, when completed, an expenditure of not less than £50,000,000.

"TUBE" RAILWAYS IN LONDON.

In the northern section of the metropolitan area the promotion of tube railways has hitherto been more active than in the south and west.

The north-west London line running from the Marble Arch, traversing the Edgeware-road, has a length, as authorised, of 4¼ miles, and its outer terminus is at Cricklewood. The Charing-cross, Euston, and Hampstead Railway, which has been authorised, extended, and altered by various Acts from 1893 onwards, and the contract for the main part of which has been let, had an application in Parliament last year for the extension to Golder's-green, &c., and this, like all the proposals of other companies, was ordered by the Joint Committee to stand over till the present Session. It will be seen that this line would effect a connection at Charing-cross with the London United Electric Railway, just as the north-west would at Marble Arch, thus affording to the public valuable facilities.

In a central position between these two northern lines we find the Baker-street and Waterloo Railway, the route of which is explained by its name. The original scheme of three route miles is nearing completion, and the extension westward to Paddington will no doubt be proceeded with in due course.

The Great Northern and Strand Railway is 6¼ route miles as at present laid out, and although it will afford at present no through connections with other "tube" lines, this will doubtless soon be rectified.

Arrangements can be made for an interchange between the London United and the Metropolitan District Railway at Charing-cross. This would secure through connections with the northern suburbs and the City and with the populous districts served by the comprehensive system of United Electric Tramways.

The Great Northern and City Railway, now being completed, possesses the interesting feature that its tubes are 16 feet in diameter. The difference in the diameter prevents any direct interchange of traffic with other underground lines; but it will have a joint station with the City and South London at Old-street, and by this means will bring north and south into direct communication.

While northwards we find so much progress with the new style of underground railway, the south-west and west regions as yet present a blank. The City and South London, as seen, comes to Clapham-common, and was the first electric railway made in London. The Waterloo lines also touch an important point in South London, but these are the only lines yet constructed south of Oxford-street, or west of Waterloo-bridge.

From Paddington to Kennington Oval, *viâ* Victoria, there is also the proposed West and South London Junction Railway.

Covering more or less the same route as is intended to be served by the east and west line of the London United Electric Railways, which I have already described, there are three other proposals promoted by the Charing-cross, Hammersmith, and District Railway, the Piccadilly and City Railway, and the Central London Railway. The two latter extend into the City. I could, of course, dilate at great length on the relative merits of these competing schemes, but having regard to my close association with the London United Electric Railways, it would, I think, be better that I should refrain from doing so.

RAILWAYS VERSUS TRAMWAYS.

I have already commented on the more favourable position as regards Parliamentary promotion enjoyed by railways as compared with tramways, and before concluding I may notice an erroneous view frequently put forward that, as regards taxation, tramways enjoy great advantages compared with railways. This is generally mere hare-brained chatter, but when a man of the calibre of Sir Ernest Paget, Chairman of the Midland Railway, gravely speaks to his shareholders of the "unfair" competition of tramways, because they "run on roads for which they pay nothing," it is needful to show the true state of matters. So far it is from being true that a tramway company pays nothing for the road it uses and the poor oppressed railways have, as ratepayers maintaining the roads, to subsidise their rivals, that the exact opposite is the case. We tramways maintain all, and often more than all, of the roads we use, and the heavy railway vans in each town use daily the excellent roads we thus maintain! Thus the boot is quite on the other leg. Further we are fully taxed on the part of the road we pay to keep up, as well as on our power-houses. We are rated on the same basis as a railway company, *i.e.*, on our profits as hypothetical tenants, and although we relieve the district rate by maintaining the road, we pay that rate in full and have no such allowance off as the 75 per cent. conceded to railway companies. And finally we frequently pay wayleaves in addition for right of way over the very road we maintain. Let Sir Ernest Paget compare the cases dispassionately. What is the average cost per mile of railway compared with the present day cost per mile of electric railway? What is the relative position of a railway company obtaining absolute possession for all time of land which is saleable and a tramway company obtaining a brief tenure of the road, liable under the general law as existing to have its lines, if successful, taken over by the local authorities? What chance has a tramway company of putting into practice that accepted railway doctrine of charging "as much as the traffic will bear?" How does the effete "penny a mile" compare with the electric tramway practice of conveying workers at considerably less than a farthing a mile? The Midland Railway laments an assumed (not ascertained) loss of £5,000 per half-year — ·01 per cent. of its revenue! Yet the only figure available is, "We have received £25,565 more, they have travelled longer distances." Precisely. Tramways are feeders, not rivals to railways, and this talk of tramways not being taxed is nonsense pure and simple, and its enunciation by the chairman of a great railway is quite unworthy.

CORPORATION VERSUS COMPANY.

Although the majority of the enterprises with which I have been concerned in this paper have been in the hands of companies, there is a point with regard to the promotion of tramways and underground railways regarding which it is necessary to say a few words.

From the earliest period I have been the zealous advocate of such enterprises being in the hands of incorporated or joint stock companies rather than in the hands of local authorities. There may be cases—though I know of none—where the advantage lies the other way. Even in the largest of our provincial cities difficulties have already arisen in the extension of tramways where populous districts have begun to arise beyond the civic boundaries. In London, with which we are more immediately concerned, the argument in favour of a company undertaking such works is especially powerful. And I say this in face of a strong desire shown in many places, that all the tramways here should be in the hands and under the management of the London County Council. The Council does not govern the whole of the metropolitan area, and even within its own bounds it possesses only a joint authority with a multitude of municipalities. How could even the initial sixteen miles of the London United have been brought into existence and worked, had it been left to any combination of local authorities to project, construct, and work them?

We have been, it is true, at a great disadvantage from the multitude of local authorities with whom we have had to deal. But we had unity of purpose and even the negotiation with three County Councils and thirty, or thereabouts, District and Urban Councils did not daunt us. We knew our own mind, and could consistently throughout pursue one definite policy. I have admitted elsewhere that this "multitude of councillors," and of Councils, might have projected and constructed each its own bit of line, and that they might have got these fragments operated as one system. Each little Pedlington would have its staff of Parliamentary agents, engineers, and contractors, each one would demand its share of the profit, if any could arise, from such a hugger-mugger of ownership and management. The accounts would be voluminous, and their accuracy would be practically impossible, while the hosts of officials would be as disastrous to the funds as a cloud of locusts would be to a green crop.

At the present moment the London United Tramways system—already operating, or under construction and authorised—traverses the territory of the London County Council, the Middlesex County Council, and the Surrey County Council, while to name the vast number of subordinate local councils would be as uninteresting as a list of Homer's heroes. Their name is legion, yet our 35 million of passengers know nothing of all this. They only see that the organisation and operation of the lines are perfect—as nearly perfect, that is, as anything human can be—that the fares are extraordinarily low, and that municipal boundaries or any other boundaries are for them non-existent. No corporate co-operation could have secured all this—that can be confidently affirmed.

On a smaller scale, our Tee side operations tell the same tale. We had originally two County Councils and three Municipal Councils to negotiate with there, not one of whom could singly have moved in the matter through statutory disabilities; and, in view of the extensions now demanded on every side, we alone can act so as to meet all wants. In face of such proofs it is hardly necessary to say a word on the much-vexed question of "municipal trading." The practical outcome suffices for my argument.

THE FUTURE.

What has the future to show in the history of electric traction?

We see this power dominant everywhere,

and the least sanguine amongst us must foresee for it a greater and more extensive development. In London there is so much room for the improvement of intercommunication, and the public demands are so pressing, that in one form or another, we look for the introduction of electric methods. What form this should take can, from present indications, be reasonably well judged. We have the electric tramways set before us in an example with brilliant success. The electric "subway" or "tube" railway has also its power and usefulness demonstrated; and the two old underground steam railways have been compelled, by the presence of opposition, to turn to electricity in sheer self-defence, although they are as yet straining "like hounds ill-coupled," instead of joining all forces heartily in the proposed work. But so much the better for those who know their own mind, and who can conceive and carry through, against all obstacles, plans for the mitigation of London's present distress.

In what form shall the power be applied on surface tramways? To this I still unhesitatingly answer on behalf of the overhead trolley. It has as yet no rival in economy of construction, in simplicity of operation, in safety, in economy as regards passengers. In expressing such an opinion it is of course necessary to be on one's guard against possible changes, even if they are not probable. In this view I cannot do better than repeat some words I wrote as recently as January, 1901, in the *Street Railway Review*, of Chicago.

> "Is there any other adaptation of electricity that will probably outrival the overhead trolley for general use under all conditions within the next ten years? I confess I have seen nothing as yet that would suggest this. Every point of view must be looked at before one system can be pitted against another. Is it cheaper, more efficient in operation, as convenient in daily use, as trustworthy in all weathers, and as reliable under all conditions; can it cope with all and every development of the public demand, is it free from danger to passengers and the public? Thus examined I see nothing in any of the existing conduit or surface contact systems to commend them either to the practical tramway man, or to the engineer. The æsthetic objection? Is that a sufficient reason? Edinburgh, or at least its Lord Provost thought so, for refusing the electric overhead wire, so economical in construction and communication to outlying districts. I think not, and shall probably continue to think so ten years hence."

I went on to say that but for two possibilities I should have struck the word "probably" out of this last sentence. The one was some startling discoveries in accumulators, the other, some discovery in electricity that should upset all our existing ideas, and send motors, generators, poles and trolleys to the scrap heap. These things are of course possible, but they are not at present "within the range of practical politics." And even if such a change should come, the overhead trolley lines could be changed at a less capital sacrifice than any other known system. I have just mentioned the "surface contact" system as one of the possible rivals of the overhead trolley, and in view of the recent introduction of that system, under the Board of Trade license at Wolverhampton, some further notice of it may be taken. It is the practice of the Board of Trade, in order that it may not stand in the way of invention and improvement, to grant a provisional license for one year to any project seriously undertaken, as this venture has been by the Corporation of Wolverhampton. As a matter of choice, I would rather experiment with a surface system than with the conduit, and at one time it seemed as if in the plan invented by Professor Sylvanus P. Thompson and Mr. Miles Walker, a success was promised. This had the striking feature that one of the never sleeping forces of nature, gravitation, was used to bring about the "cut-off" from the stud on the roadway when no car was passing.

But my experience, so far, is wholly opposed to any surface-contact system yet in practice. The rattle and row of the "skates," as at Monte Carlo for instance, would not be tolerated in this or any other country. In Paris, the line originally laid down is now being superseded by the overhead trolley, although I understand another attempt is now being made elsewhere to resuscitate the surface-contact system. At Wolverhampton the Corporation has entered on the bold scheme of allowing 11½ route miles to be fitted for surface-contact working. It is pleaded in a laudatory description of the lines that the projecting studs between the rails cannot be seen in a photograph. But it is admitted that "the contact studs must project above the paving." Supposing that undoubted disadvantage to all other traffic to be tolerated, how is the danger of the stud remaining "alive" to be securely guarded against? The plan here depends, as in Professor Sylvanus Thompson's, upon gravity, but hardly, I think, so effectively applied. It may be said with confidence that no number of successful workshop tests can give actual security in rough daily work, and this seems to be recognised in the case of Wolverhampton.

Will electricity itself be one day superseded by another power? It would be too hardy to deny such a possibility. It may be recalled that some years before the railway jubilee in 1875 the question of the State acquisition of our railways was discussed, when the *Times* ventured to express the view that there was little likelihood of the capital then sunk in railways losing its value through the introduction of some rival power. Could such an opinion be confidently expressed to-day, when the abolition of the locomotive is actually a matter of anticipation; and when not only have we sound estimates made, of the cost of conversion of the existing form of railway, but when we have the mono-rail of Behr, with carriages and locomotives astride a central rail, as A, and Smith's alternative idea, the mid-rail, having the centre rail at the bottom of a groove, as V, threatening to render an almost total reconstruction of the present railways necessary? In view of all this, we may be a little careful as to prophesying. But I have not gone beyond ten years in any opinion expressed, and I shall be much surprised if even ten years hence anything better can be found for London that the idea put forth by last year's Joint Committee, as to how the terrible problem of London intercommunication can best be dealt with.

In concluding these notes I must express my feeling that, notwithstanding the length to which this paper has extended, even the time and space occupied have been inadequate to the satisfactory or full treatment of so great a subject. I have endeavoured to cover the ground as far as possible, but it is evident how much in the way of detail would be required to do even partial justice to the vast question.

The solution of London's great problem opens up many points of controversy, and in considering these, I would plead wholly for the public interest. Whatsoever proves on examination to be essentially best for the public, should also prove best for those who are striving to serve it. Efficiency being in the first place demanded, then whatsoever is easiest and readiest to be done, whatsoever is most economical as regards fares, and most thorough in organisation and management, whatsoever is safest, quickest, most convenient, and comfortable for the millions of London should be sanctioned by Parliament, and at once begun to be carried out. Senseless and archaic obstacles to legislation should be ruthlessly set aside, and all personal and vested interests should be made to give way before the clamant cry of London. The "bane" is seen and known of all men, and I have striven to show that the "antidote" stands ready to our hands. And I shall feel proud indeed if to-night I shall have stirred thoughts which will hasten even one step in the great and overwhelming task of removing the congestion of the streets of London, and making more easy and more rapid the intercourse between all parts of the metropolitan area.

DISCUSSION.

Mr. E. T. SCAMMELL said he was glad Mr. Robinson had spoken so emphatically on the question of corporations and companies, although he did not altogether agree with Mr. Robinson's conclusions. He would very much prefer that there should be a central authority which had power to deal with roads and streets in a manner at present denied to the Board of Trade. The work being done by the London United Tramways Company was a very great one. Mr. Robinson had shown very clearly how in that part of the metropolitan area in which that particular tramway authority worked, the difficulties relating to the boundaries of the various local authorities had been overcome, and a splendid system of electric traction introduced. As a citizen of London he sympathetically viewed a great deal of the work being done by the London County Council, although at the same time he acknowledged the great work performed by the Company represented by Mr. Robinson. He quite agreed, so far as the æsthetic aspect of the question was concerned, that the installations seen in the various parts of the metropolis left little if anything to be desired; the appearance and general method of carrying out the work were good; therefore, at present, in the main, he was in favour of a continuation of the overhead system.

Mr. ALEXANDER SIEMENS said he was not so absolutely in favour of the overhead trolley system as the reader of the paper, and thought the conduit system where it was properly carried out had its claims. The conduit system in Buda Pesth, which was now 12 or 14 years old, and had been continually extended, gave great satisfaction; a similar system in Washington working extremely well. The fact that the trolley system was cheaper must never be lost sight of. Whatever might be said for various systems the ultimate arbiter in the adoption of a particular system lay with the £ s. d. If a system which electrically was as good as another was cheaper it would be introduced, while if it cost more it would not be adopted, however scientifically interesting and otherwise attractive it might be. In order to relieve the traffic in the London streets it was necessary to have a means of communication in the centre part of the metropolis, with as close a connection as possible with the outlying districts. The plan which the London United Tramway Company had in view of working their system in connection with tubes was excellent; but he believed the Parliamentary Committee, last year, was very much in favour of the adoption of tubes which should run right through to the East-end, not stopping at Charing-cross, connection being obtained there with tramways to outlying districts. Incidentally, he wished to protest, as a British manufacturer, against the idea of it being necessary to go to America for tramway outfits. It was not at all necessary. It must not be forgotten that British manufacturers during the last five years had been handicapped through various causes. The great engineering strike threw the completion of orders frightfully back; this was followed by a period of good business, the result being that all British manufacturers were overcrowded with work. The works with which he was connected could not have done more work than they had done during the last five years; in fact, many orders were refused. It would naturally be asked why the manufacturers did not extend their works. It was not wise to extend plant when there was a rush of orders, because it was not known how long such a flourishing state of business would last, so that a prudent manufacturer would extend slowly. If manufacturers extended too quickly they would, to use a Yankee expression, "get left," and have to look out for orders, as their cousins in Germany were doing at present. To disprove the assertion that American manufacturers were very much better than the English it was only necessary to point out that American companies came over and opened works in England, the produce obtained being equally as good as that made in the States. The mere fact that an American company came to England and opened works showed their confidence that the work could be done quite as well in England as in America. He knew that in several cases English manufacturers had actually beaten Americans, and he was quite sure they could do it again. He hoped when the reader of the paper placed his orders for his various companies, he would not forget the British manufacturer.

Mr. S. Z. de Ferranti said Mr. Robinson had spoken of the great engineering skill and work necessary to carry out the various undertakings dealt with in the paper; but he could assure the audience that the skill and work required to overcome the opposition and difficulties put in the road by Parliamentary and local authorities were very much greater and required much more work and skill than any engineering difficulties ever met with. No one who had not spent a life time in overcoming such difficulties could possibly appreciate the immense work performed by the reader of the paper in inaugurating the big system of electric tramways, to which reference had been made. He hoped Mr. Robinson would continue his movement for the alteration of the laws of the country so that industry would, instead of being hampered in every possible way, be facilitated. It had been stated in the paper that it was necessary to go to the United States for the machinery required to carry out the works. While agreeing that the necessity had existed he would like those present to realise how it had been brought about. This country, on account of its legal systems and obstructions put in the way of progress, so far retarded the advancement of the application of electric tramways that the country fell much behind other countries in the electrical industry, with the result that other countries which fostered enterprise, instead of stopping it, had had the opportunity of a large practical experience in the construction of apparatus necessary for carrying out such works. In that manner they obtained an immense start, simply by means of the facilities which they possessed, and not on account of their superior skill. With such an example before them, it was to be hoped that things would be altered, so that England would not suffer in the next industry that came along, in the same way that it had suffered in the electrical industry. Mr. Robinson had not referred to the carrying of goods traffic at night, which in the tramways of other large cities of the country would be a most important consideration. He very strongly believed there were immense prospects in that direction. He hoped Manchester would be go-ahead enough to see the value of the adoption of such a scheme. At Mulhausen on the Rhine, he had seen a system in operation, in which the carriage of all sorts of merchandise was carried on by cars which ran in between the tram cars used for carrying people. He believed, especially in the Lancashire district, great advantage would be gained by all important works having sidings and their own rolling stock, which could be loaded in the day time, and taken away during the night, over the lines throughout the town. At present there was in contemplation a very large application of that idea in Lancashire; but he was sorry to say it was being very much retarded by the obstruction of local authorities to the use of the lines in such a manner.

Mr. Ernest Benedict thought that as a new Act dealing with the industry was to be formulated during the year every effort should be made to get it properly drawn up, so that the great difficulties referred to in the paper might be in a large measure removed.

Mr. W. M. Mordey wished to combat the idea, so often expressed, that the industries of the country were in a backward condition. England was the pioneer of electric traction. Years before any tramways were running in the States, street tramways were running in England by the method now in use in America. When the first tube railway, the City and South London, was opened in 1890, the Americans sent over a deputation of engineers, who reported that it was impossible for such a system of traction to take the place of steam traction on the overhead railways. After the Liverpool overhead railway was opened another American deputation was sent over, with the result that a Chinese copy of that system was installed on the Chicago overhead railway. Yet the Americans when they visited England were welcomed as the pioneers of electric traction. Also, he did not think it was right to assume that England was behind European countries. If the money invested in electric lighting, power and tramway enterprises in the three principal countries of Europe was taken, it would be found that while for every person in Great Britain 17s. 6d. were invested, in Germany it was only 10s., and in France 6s. 8d. Mr. Siemens had expressed the belief that this country was not behind Germany in a business sense. The Germans, not having the conservatism of the English, had over-produced their works, with the result that they had provided facilities for manufacturing which had forced them, in order to keep their factories going, to sell things at less than cost price. As a consulting engineer, he could buy from the Continent excellent electrical plant at less than its cost to make in Germany, and 50, 60, and 70 per cent. less than wise English manufacturers would sell it for. America, having no roads fit to walk or ride on, aud no horses or 'buses, had been driven to establish electric traction services. It was not due to the enterprise of Americans, but to the absence of any other facilities for getting about, that the great tramway work had been done in the States. Even there the business test ought to be applied; and it would be found that while the actual values of electric tramway and lighting undertakings in this country, on the average, were far above par, in the States the reverse was the case. In many instances the lines had been constructed to help the manufacturers, but as business enterprises they had not been successful. One American Company alone had had to write down its capital 25,000,000 dollars within the last three years. The question whether there were any alternatives to the present methods of electric traction deserved very careful thought. Probably there were not. No advance had been made in the last twenty years in the construction of accumulators. Having had charge of the first accumulator, of any size, used in this country, at the Crystal Palace Exhibition, 1882, and having tested four-fifths of the accumulators brought out since, he believed he was correct in his statement that, except in the use of purer material and the adoption of greater care in their use, there had been scarcely any advance in that branch of industry. Although accumulators might be largely used to supplement the power of the generating station, there was no possibility of the trolley, conduit, or surface-contact systems being replaced by any system worked by accumulators, however attractive the idea might be. Whether the trolley wire system would be universally adopted he did not know; but, like Dr. Thompson, he hoped some day it would be possible to combine the surface-contact system used in the middle of the town with the trolley wire system used in the outlying districts, and in that way obtain the greatest convenience, without incurring any prohibitive expenditure.

Mr. JOHN LEIGHTON thought that from the point of view of art, the adoption of a tube system of railways would be a great advantage. At present, Ludgate-hill was spoiled for ever by an abominable lattice railway bridge, while the appearance of Blackfriars-bridge was injured in a similar manner.

Mr. LEON GASTER expressed the opinion that the descriptive great work performed by the reader of the paper in the past would create a favourable impression as to what electric traction could do in the future.

Mr. PETER MCMAHON thought the English manufacturers were, to a certain extent, to blame for so many orders for plant being sent abroad, because they made promises as to delivery without any idea of fulfilling them.

The CHAIRMAN said that Mr. Robinson had brought forward in a most forcible manner the extraordinary and illogical condition of things under which any enterprise of such a kind was perforce compelled to work. Was it possible to imagine a more foolish state of the law than that which brought the industry to the condition of stalemate upon certain portions of the London United Tramways system? Mr. Robinson desired to fill up little connecting bits of line to complete the Hammersmith end of the vast system of lines. He was opposed by the London County Council, who were rival promoters and wished to put their own tramways there, and the London County Council was opposed by the local authority of Hammersmith, which preferred Mr. Robinson, who was already on the spot, and no one of the three parties could proceed. It was also impossible to promote a Bill in Parliament to deal with the little pieces of line, because the question was governed by the clause of the Tramways' Act, which did not allow the promoter to prove standing orders unless with the consent of the local authority. There was no question that the Tramways' Act of 1870 proceeded upon the assumption of no tramway extending beyond the limits of any one local authority, and that the people of those times had no idea of inter-urban communication, or of communication from the centre of a large city to its outlying suburbs. The idea that any single local authority should exercise an absolute veto on a system which extended into its district, for any outside authority was too absurd. Mr. Robinson had not referred to the fact that in this country there was a most glorious muddle of gauges, far worse than was the case in the early history of railways. For example, the tramways in Leeds and Bradford were of a different gauge. The two systems met in the town of Pudsey, but owing to the difference of gauge it was impossible to run straight from Leeds to Bradford, or *vice-versâ*, without changing cars. General Webber had once suggested to him that military considerations ought to have compelled the nation to provide that only one gauge for tramways could be adopted. He had often wondered that an attempt had not been made to standardise a gauge for all large cities, but apparently every local authority could do what was right in its own eyes, and he was not sure whether, when there was rivalry between local authorities, a different gauge had not been chosen in order to spite the neighbouring authority. The question should be looked at not from the point of view of a particular vestry, district council, or county council, but from the larger point of view of the convenience of the nation. Allusion was made in the paper to the possibility of a system of surface contact being tried. Personally, he had advocated the use, inside towns and cities, of the surface contact system of tramways, which would do away with the necessity of using overhead wires—not that he objected to the overhead wires from the æsthetic point of view, but from the point of view of keeping the thoroughfares clear for fire-escapes, &c. He had never advocated a system of surface contact for running through suburban districts; that would be absurd, but not nearly as absurd as putting a conduit in the open country. One advantage of the surface contact over the conduit was that it was less expensive. As Mr. Mordey had said, the essential point in surface contact work, was that it must be a system which would co-operate with the overhead line, in running out into the outside districts. There was no reason why a car, equipped with the skate underneath, which took the current from the surface contact, when it was run through the crowded part of the city, should not also be equipped with a trolley-pole, so that it might take its current from the overhead lines when it arrived at the outlying districts. In connection with the European origin of electric tramway work, and the British origin of tube railways—a fact which so many newspaper writers appeared to forget—it should be remembered that there would have been no tube railway along central London if the two pioneer tube railways, the City and South London and the Waterloo and City Railway had not been constructed ten years before. He emphasised the necessity of looking at the question from the large point of view. Not only must the procedure and methods in laying out tubes and trams so that they worked harmoniously together be systematised, but they must be systematised from the point of view of Greater London. Promoters should also systematise their method of going to work to get powers and insist on the abolition of those insane corners in the law which brought about a position of deadlock on such little details as putting together a few hundred yards of line to connect up with the main system.

Mr. Clifton Robinson, in reply, said that Mr. Siemens's remark that price was the predominant factor in determining the mode of traction was altogether erroneous in connection with the United London Tramway Company. The company felt that an installation had to be made that would at once determine the question of electric traction for London. If they had considered merely the cost they would not have gone to the expense in West London of installing overhead trolley wires, which cost more than the ordinary estimate for a conduit system. The lines in London, when completed, had cost no less than £30,000 a mile, for which expenditure a modern conduit system could have been built. There was no system of electric traction which would meet every condition: it was felt that for outlying districts, particularly lines radiating from the busy centres of London, the conduit system was not suitable. The question raised by Mr. Ferranti, in connection with goods being carried by tramways, had been under discussion for a long time. When railways were originally introduced into the country they were intended mainly for passengers, goods being a secondary consideration. The Tramways' Act of 1870 contained wide and sweeping rules for the conduct of the goods traffic, and yet in no instance had any tramway in the country, in over 32 years, ventured to make the experiment. He had gone as near as possible by introducing in some places a light parcels delivery in connection with tramways. In London, at least, he did not think it was possible to conduct a night goods service, because in West London the tramway was worked on the day and night passenger service for 22 hours out of 24, and at times the whole 24 hours had been worked. The surface contact system had received very considerable attention at the hands of the Company. At one time it was thought possible that such a system might be adopted on some of the sections, but owing to circumstances beyond their control it was impossible to carry out the plan. He had yet to see in practice a surface-contact system such as Dr. Thompson had mentioned. He believed it had, in certain places under favourable conditions, a future before it. If he were asked to choose between the two he certainly preferred the contact system to any known system of conduit. He thought the time was near when there would be an amendment to the Tramways Act, and it would be a very good thing for the electrical industry when that time approached. He was sure it would do a great deal to accelerate the development of electric traction throughout the country.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Robinson for his paper.

Miscellaneous.

TELEGRAPHIC COMMUNICATION WITH INDIA.

On the 1st of March the charge for private and official telegrams between England and India was reduced from 4s. to 2s. 6d. per word, and for Press messages from 1s. 4d. to 1s. Telegraphic communication between this country and the Indian Empire is carried on chiefly by means of the Eastern Telegraph Company's submarine cables; but there are two other systems, that of the Indo-European Company and that known as the Turkish route. The Eastern Company's route possesses the additional advantage of being practically all-British, although its messages have to be conveyed across Egypt, and only one of its Indian cables goes direct to Gibraltar without coming into contact with foreign territory. Of the remaining three cables that start from the neighbourhood of Land's End, one touches at Vigo and two touch at Lisbon. From Vigo to Gibraltar there are two cables—one direct, the other *viâ* Lisbon. From Lisbon to Gibraltar there are also two. From Gibraltar to Malta and thence to Alexandria there are three. From Suez to Aden there are four, two of which proceed direct, and the other two *viâ* Suakin. From Aden to Bombay—the terminus—there are three cables. Telegrams intended for the Far East and Australasia pass over the Indian land lines from Bombay to Madras, and are then cabled to their destination *viâ* Penang and Singapore, by the Eastern Extension Company. From Constantinople the Turkish route passes through Diarbekir and Bagdad, joining at Fao the Persian Gulf lines belonging to the Indo-European Department of the Government of India. The Indo-European Company's route traverses Germany, Russia and Persia, meeting the Department's line at Teheran. The establishment of the Karachi-Fao line by the Indo-European Department dates from 1864. The route now used by the Indo-European Company was opened six years later, and the competition of the cables also began in 1870. After a time the two companies started a joint purse, and eventually thought it to their interests to induce the Indo-European Department to join them under terms which have been found in some respects very irksome. For example, the agreement can only be determined (1) if a route is permanently interrupted for a period exceeding thirty months. (2) If the German concession to the Indo-European Company is not renewed in 1904. (3) If either the Persian or Russian concession to the same company is not renewed in 1925; or, finally (4) by mutual consent of all parties. This joint fund is distributed normally in the following proportions:—

	Cis-Indian Messages.	Trans-Indian Messages.
Eastern Telegraph Company	59·82 ..	80·53
Indo-European Telegraph Company..	22·12 ..	12·03
Indo-European Department	18·06 ..	7·44

In November 1900 an Inter-departmental Committee, of which Lord Balfour of Burleigh is chairman, was appointed "to enquire into the present system of telegraphic communication between different parts of the Empire, and to consider in what respects it requires to be supplemented; to investigate the relations between private cable companies and the Imperial and Colonial Governments (including the Government of India), the amount of control at present exercised by these Governments, and the policy which should be pursued by them in future, especially when new concessions are sought; to examine existing rates, to report how far they are fair and reasonable, and, if not, how any reduction should be effected." In its first report, recently issued, the Committee observes that Russia and Germany are enabled by the above-mentioned pooling arrangement, coupled with the concessions granted to the Indo-European Company, to veto any proposal for reducing the Indian tariff. The Committee also points out that Russia at any rate derives a similar power of veto from certain regulations of the International Telegraph Convention, to which body it seems that practically all the more important nations, except the United States and China, and our Colonial possessions, except Canada and Newfoundland, adhere. The Committee recommends that these regulations should be amended at the conference to be held in London this year, and that the earliest opportunity should be taken to terminate the existing joint purse agreement, adding, that if subsequently it appears desirable to renew the arrangement, in a revised form, such a renewal should be made for a moderate period, not exceeding say five, or, at most, seven or ten years. In the opinion of the Committee, it is of the utmost importance that any country in direct communication, by means of a cable, with a colony or dependency of its own, should be allowed to fix its tariff between such places. "The preponderance of British cables is," says the committee, "still very great; an arrangement which enables any foreign power possessing a fraction of a competing line to veto reductions on British lines constitutes an extreme anomaly; and the possibility of this veto is the more irritating because of its uncertainty, and because the veto may be used for purely vexatious purposes, or to gain a point in a general diplomatic bargain." It is believed that the delay in publishing the Committee's report, which is dated 8th August, 1901, is due to the action of the German and Russian Government, in so long withholding their consent to the reduction of the Indian tariff announced above.

It has been decided that if at any time after the introduction of the 2s. 6d. rate, the average revenue of the Cis-Indian Joint Purse of the three preceding years, whether wholly at 2s. 6d. or partly at 4s. and partly at 2s. 6d. a word, amounts to £360,000, a rate of 2s. a word will be at once introduced, that is if the Foreign Administrations interested do not interpose an effectual block. The Government of India have expressed their willingness to undertake, for ten years, to pay one-third of the amount by which the yearly receipts fall below £360,000, subject to a maximum liability of £45,000. In some quarters it is expected that one effect of cheapening the rates may be to induce merchants and others to gradually discard, or, at all events, curtail the codes now so extensively used, and that in the long run, the earnings of the companies will not suffer. On the other hand, it must be remembered that telegraph codes, commercial and otherwise, are used for the purpose of secrecy, as well as for the sake of economy.

TEXTILE INDUSTRIES OF GERMANY.

Among the various products which form a component part of the foreign commerce of Germany, textiles hold an important place. The great industries of the manufacture and export of silk, cotton and woollen goods are kept alive by the importation of nearly all the necessary raw materials. The German manufacturers draw their supplies of raw cotton from Egypt, India, and the United States—the quantities imported from these countries in 1900 being respectively, 25,000, 26,000, and 256,000 tons. Small quantities of cotton find their way into Germany by way of England, Belgium, France, Holland, and Italy. The cotton of Egypt and India can be used only in the manufacture of certain textiles, while American cotton is used in the production of almost every grade and variety. In recent years India has increased her consumption of home cotton, and this has caused Germany to enlarge her use of Georgia cotton. Russia supplies one-third of her cotton consumption from Caucasia, Persia, and Turkey, so that very little cotton from those countries finds its way into German markets. Of flax, Germany produces only 10 per cent. of the quantity needed to supply her mills. In 1900, over 31,000 tons of flax, valued at £1,000,000, were imported into the Empire, fully 90 per cent. of which came from Russia. Much of this flax is reshipped by traders in Köngsberg and Breslau to France, Bohemia, and Belgium. In former years, Germany produced a much greater quantity of flax than she does to-day. The introduction of cotton as a substitute in the linen industry, together with the development of railways in Russia, has had much to do with the decline of flax cultivation in Germany. Of hemp and pite, Germany produces but little. Vast quantities, however, are imported from Russia and Italy. In 1900, more than 45,000 tons of hemp, valued at £1,200,000, were imported. Tow and oakum were also imported from Russia in large quantities. Jute is gradually securing a prominent place in the manufacture of textiles. Germany imports annually about 70,000 tons. Sheep breeding in Germany is rapidly on the decline. Pasture lands adapted to grazing have been compelled to give way to the plough, and cheap ocean freights which have enabled the wool-growers of Argentina, Australia, and Cape Colony, to underbid home products, have sealed the fate of this industry in Germany. Consul Harris, of Eibenstock, says, that in 1860 there were 28,000,000 head of sheep in all the different states, which to-day compose the German Empire. In 1873, this number was reduced to 25,000,000. The statistics for 1883 show 19,190,000, and for 1892 only 13,590,000. In the autumn of 1897 there were 10,000,000 sheep in Germany, or a decrease of 18,000,000 in forty years. This is the more significant when we consider that mutton forms a staple food product in the sustenance of any people, and especially so in Germany, where the inhabitants increase at the rate of 800,000 annually. At the present time Germany is only able to supply 25 per cent. of the wool necessary for the textile industries. In 1900, nearly £10,000,000 worth of imported wool was consumed by the textile industries of the Empire. As regards silk, many attempts have been made to cultivate silkworms in Germany. As far back as 1850 experiments were commenced, and they have often been repeated during the intervening years. The climate is not adapted to the culture of the mulberry, and thus far no equivalent has been discovered which will produce the same results. The total imports of raw materials necessary to sustain the various textile industries of Germany, amounted in 1900 to the value of £36,600,000; the import of piece goods, finished and otherwise, and all textiles, whether manufactured or in an unfinished condition, amounted to 18,000,000. The total exports of textiles from the German Empire in 1900 amounted to £48,600,000. In 1895, there were 995,257 persons employed in factories directly engaged in the manufacture of textiles. The tendency in Germany, with a few exceptions, is for large factories to rapidly absorb small ones. In 1897, the total production of all the textile factories in Germany amounted in value to £91,000,000. Of this sum, £42,600,000 worth was consumed at home. There are 150,000 persons employed in Germany in the manufacture of cotton goods. The countries which consume the greatest quantity of these goods, are England, Holland, Switzerland, Argentina, and Chili. German exports of cottons to South America have, however, declined in recent years. Nearly 100,000 persons are employed in the manufacture of hosiery in the German Empire. The annual output amounts to £7,100,000. The German hosiery industry is situated principally in the Kingdom of Saxony. The German linen industries are located in Silesia, Lower Lausitz, Saxony, Westphalia, Wurtemburg, and Alsace. The statistics for 1897 placed the number of persons employed at about 80,000. There are more than 20,000 persons in Germany engaged in making cordage, thread, fishing nets, sails, sacks, &c. The annual output amounts to £800,000, one-fourth of which finds its way to Great Britain, Russia, and Denmark. On the whole, Germany's silk industry is on the decline. High duties, together with foreign competition, have placed German silk producers at a great disadvantage.

England and the United States are the two most important markets for German silk goods. There are about 120,000 persons engaged in spinning and weaving silks in the country. Of woollen goods, Germany exported in 1900 £10,600,000. The wool-weaving establishments of the Empire give employment to 160,000 persons. In addition to the above-mentioned textile products, Germany produces carpets, rugs, clothing, corsets, hats, caps, artificial flowers, and feathers. In addition to the 993,257 persons employed in factories directly engaged in the manufacture of textiles as mentioned above, fully five times this number are indirectly engaged in these industries, says Consul Harris. The traders in cotton, flax, wool, and silk, with all their *employés*, the wives and children of the workmen, the interests connected with the outbound ships from Hamburg and Bremen, with their cargoes of woollen goods, hosiery, cotton and wool gloves, silk goods, trimmings, laces, lace curtains, &c., are all indirectly dependent upon the prosperity of these industries for an existence.

Correspondence.

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THE INDUSTRIAL DEVELOPMENT OF INDIA.

I ask for the publication of two paragraphs, which were inadvertently omitted at the time of sending my manuscript to the printers. The first should be read, after "without difficulty" (page 345, column 1, line 4).

"There are, in India, considerable number of railway workshops, canal works, and other factories where Indian workmen have produced articles equal in quality and strength to any of those produced in Europe. But this progress in technical skill seems to be confined within the four corners of the workshops, and has little effect on the general community of workmen, even in the vicinity of such works. An artisan who may have been the best of his class inside the workshop, can do practically nothing, if he is thrown out of the establishment. Industries of various sorts are also taught to the criminals in Indian gaols, such as carpet making, cane work, carpentry, &c., but these men, even after attaining proficiency in these handicrafts, scarcely follow them up for earning their livelihood, on their release from prison."

The second, on the same page and column, should be read at the end of the first paragraph.

"Stress may be laid on the desirability of organising exhibitions in large and small towns where the masses of the people can see the latest agricultural and factorial implements and machines in fully working condition. Facilities may be afforded and encouragement given to the castes interested in the exhibits for visiting the exhibition and obtaining practical instruction which may be useful to them in their occupations."

I regret that these omissions should have taken place, especially as the first of them bears on Mr. Benedict's most pertinent remarks.

N. B. WAGLÉ.

SOUND SIGNALS.

Mr. Price-Edwards's interesting paper on Sound Signals, which appears in last week's issue of the *Journal*, will tend to foster inventive faculty on this important subject, and may possibly result in the adoption of a more efficient and reliable instrument for lighthouses and coast signal purposes. When Mr. Price-Edwards read a paper on the same subject in 1880, the pressing want then was for a lighthouse signal that would sound high and low notes, in order to prevent the signal from the lighthouse station being mistaken for a steamer's fog whistle.

A few months after Mr. Price-Edwards's paper had been published (1880), I had the honour of submitting for practical test, before Admiral Sir Richard Collinson, Sir James Douglass, and others, an inventions that gave out from one cylinder bell, two distinct notes, viz., high and low, and the device was so arranged that these two notes could be put in combination which produced harmony. I know for a positive fact that this signal for giving from one bell two separate and distinct notes would never have been brought out had it not been for Mr. Price-Edwards's last paper (1880). A report of the test and a full description of the invention was sent by me to the *Journal*, vol. 29 (1881), pp. 452-3. Since the invention was made many thousands of this signal have done duty. The siren is a capricious instrument unless made on a principle that insures certain and instantaneous action, and is free from the possibility of jamming. In the experiments made at St. Catherine's Point it appears that two kinds of sirens were under test, viz., the cylinder and disc type. There is another well-known siren made on the principle of a turbine or propeller, which acts on the sound beam as a force pump or ejector. As soon as the compressed air or steam escapes through the radial slots the rotation of the turbine drives with great velocity the sound waves through the mouth of the trumpet causing their audibility to be heard at great distances. The formation of sound by the method described by Mr. Price-Edwards on the revolving cylinder principle tends to weaken the pressure in its passage through the vertical slots to the trumpet mouth, whereas the turbine device greatly intensifies the air current when emitted from the sounding chamber. Experiments of the sounding properties of all kinds of signals made on land and under various conditions prove the siren has the greatest penetrating power, and the low note under all conditions would assert its first claim to distance could it be produced in a 5 inch or 7 inch chamber when its cylinder or turbine were making between four and five hundred revolutions per minute.

It has been found by land tests that sound propelled from its source at a pressure of 100 lbs. travels considerably further than when projected at low pressure.

ISAAC SMITH
(Sydney Smith and Sons,
Nottingham).

Hickling-lodge, Notts.
March 11th, 1902.

General Notes.

BRITISH FORESTRY.—A departmental committee has been appointed by the Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, to enquire into and report as to the present position and future prospects of forestry, and the planting and management of woodlands in Great Britain, and to consider whether any measures might with advantage be taken, either by the provision of further educational facilities or otherwise, for their promotion and encouragement. The following are the names of those appointed to form the committee:—Mr. Ronald C. Munro-Ferguson, M.P. (Chairman), Sir John F. L. Rolleston, M.P., Mr. Edward Stafford Howard, C.B., a Commissioner of his Majesty's Woods, Forests, and Land Revenues; Professor W. Schlich, C.I.E., Ph.D., Professor of Forestry, Royal Indian Engineering College, Cooper's Hill; Colonel Frederick Bailey, R.E., Lecturer on Forestry, Edinburgh University; Professor John R. Campbell, B.Sc., an Assistant Secretary to the Department of Agriculture and other Industries, and Technical Instruction for Ireland; Mr. John Herbert Lewis, M.P., Mr. George Marshall, and Dr. William Somerville, an Assistant Secretary to the Board of Agriculture. Mr. Reginald H. Hooker, of the Board of Agriculture, is the Secretary to the committee.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

APRIL 9.—"Ceuta and Gibraltar." By MAJOR-GEN. JOHN F. CREASE, C.B. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, will preside. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 17.—"Recent Developments in Punjab Irrigation." By SIDNEY PRESTON, A.M.Inst.C.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab.

MAY 1.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 25.—"The Sphere of State Activity in Australia." By the HON. SIR JOHN ALEXANDER COCKBURN, K.C.M.G. The RIGHT HON. SIR CHARLES W. DILKE, Bart., M.P., will preside.

APRIL 22.—The reading of the paper announced for this date, "British Commercial Prospects in the Far East," by Mr. Byron Brenan, C.M.G., has been unavoidably postponed.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

APRIL 8. 8 p.m.—"Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington.

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." Four Lectures.
April 14, 21, 28, May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 24...Irish Literary Society (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 8 p.m.
Imperial Institute, South Kensington, 8½ p.m. Mr. John Howard, "Nova Scotia."
Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. C. H. Bedell's paper, "The Insurance of Buildings against Fire."
Actuaries, Staples-inn Hall, Holborn, E.C., 5½ p.m.
Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, MARCH 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Sir John Alexander Cockburn, "The Sphere of State Activity in Australia."
Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m. Mr. W. C. Copperthwaite, "The Greenwich Footway-Tunnel."
Civil Engineers, 25, Great George-street, S.W., Mr. Arthur H. Haigh, "Subaqueous Tunnelling through the Thames Gravel: Baker-street and Waterloo Railway."
Photographic, 66, Russell-square, W.C., 8 p.m. Mr. Charles S. Butler, "The Photographic Investigation of Modern Astrophysical Problems."

WEDNESDAY, MARCH 26...British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.
Chemical, Burlington-house, W., 8 p.m. Annual Meeting.
Geological, Burlington-house, W., 8 p.m.
Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

Journal of the Society of Arts,

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FRIDAY, MARCH 28, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

COLONIAL SECTION.

Tuesday afternoon, March 25th; The Right Hon. Sir Charles Wentworth Dilke, Bart., M.P., in the chair.

The paper read was "The Sphere of State Activity in Australia." By the Hon. Sir John Alexander Cockburn, K.C.M.G.

The paper and report of the discussion will be printed in a future number of the *Journal*.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, March 4, 1902; Walter Crane, A.R.W.S., in the chair.

The paper read was—

STRUCTURAL COLOUR DECORATION OF THE INTERIOR OF PUBLIC BUILDINGS.

By Gerald C. Horsley.

I think that before I presume to say anything on this subject to-night it is due to my audience to offer some explanation as to how I find myself, an architect, in this position. When I was most courteously asked if I would read a paper before the section on this subject, I felt at once that this was really a painter's subject, and that it would be better if a painter—one of those who we know are not only wishing to paint in public buildings, but who are also very capable of performance—should be asked to deal with it. But reflection reminded me that it is an architect's subject too; one common to architects and to painters, one both must be interested in, and one both must have at heart; consequently, though with misgivings as to my capability to say anything worthy of its importance, I could not for a moment refuse on the ground that it had nothing to do with me. It is a subject which by practice, and by study, an architect should try to make his own, and which draws him into close amity with the workers in the other crafts. None gives them better the opportunity of working together, and proving the truth of Stevens's words, "I know but one art." We know how close this union was in the past, and what immortal works it accomplished, and though the association is not now so frequent, there are at any rate signs that the ancient sympathy has revived, and is bearing fruit, small the yield perhaps now, but soon we may hope an hundredfold. This sympathy, once so full of life, has slept of late, awaking fitfully at times, but ready always to burst out into fullest life when demand is made.

The subject which we are to discuss to-night is a wide one, for it includes the consideration of a large number of building methods, and of various schemes of decoration. It may, I think, be said to embrace those many systems of decoration which by their nature are one with a building, or an actual part of it. It does not include those likewise numerous forms of decoration which are easily removed from the building they are intended to adorn.

For instance, the Palazzo Pubblico at Siena with its large frescoes illustrating good and bad government, intended to instruct the Sienese in that essential matter, comes within our view; but the great council hall at Venice, on the walls of which are stretched the largest canvasses in the world, including the Paradiso of Tintoret, however much we may admire them, does not. Nor does the modern council chamber, poorly decorated with a portrait or two of a former or present mayor, except as a reason for lamentation and hope of change. While, therefore, the subject is a wide one, it has strict limits which it will be necessary to observe.

Perhaps it would be as well for me to define a little more clearly what I consider these limits to be. The title "Structural Colour Decoration of the Interior of Public Buildings" makes me at once think of two kinds of public buildings, namely, first of those which have been constructed of such materials as to carry out a previously conceived scheme of colour decoration; it implies that the floors, the walls, and the roofs have been constructed of materials which make up a colour effect.

Then, secondly, I think of those public buildings, which after their completion in the rough, have been decorated in colour, in a manner which makes that colour one with the materials. Therefore, we may consider our subject in two parts or divisions :—

1. Those buildings whose actual materials form a colour scheme, such, we will say, as the Duomo at Siena.

2. Those buildings, which on their completion have been decorated in colour in a manner which makes that colour one with the materials of the building, such as S. Francesco at Assisi, or the Borgia apartments in the Vatican.

Just as there is no hard or fast rule in art or in her methods, so do these two kinds of decoration overlap, and react upon one another, for of course one building may represent both.

It is hardly necessary perhaps to define for our purpose a public building. A cathedral, a church, a parliament house, a town hall, a meeting hall, a theatre, a railway station, all come within our view and open a wide field for consideration, wider, I fear, than the time at our disposal will permit us to consider.

The methods of decoration possible under the two main heads I have named are as various as the types of building I have suggested. The colours of the stone and wood used, fresco, tempera, oil paint, plaster work, sgraffito, mosaic, tile work—all have a claim to a place in our thoughts.

Unfortunately, we have to realise that although this wealth of art methods is open to our use, and though we have intimate knowledge of its processes, there are but few public buildings in this country which have any structural colour decoration, and that there is but little demand from the public for works of the kind. It is a remarkable fact that since the 16th century in England the practice of decorating in colour all our buildings, both public and private, as a natural and expected action, has declined. It is as if our countrymen, who lavished colour in cathedral and castle during the centuries preceding the Reformation, had suddenly lost all hearty desire to beautify their buildings in this particular way. We know that England was not behindhand in knowledge of the decorative arts. The remains of the noble craftsmanship in painting and sculpture of the 13th and 14th centuries go to prove that Englishmen knew how to paint and to carve. The late Professor Middleton has said of English art from 1260-1320 :—

> "The painting of England was unequalled by that of any other country; even in Italy, Cimabue and his associates were still labouring in the fetters of Byzantine conventionalism, and produced no works which for jewel-like colour and grace of form were quite equal to the painting under Edward the First."

Encouraged by Kings such as Henry the Third, and by the Church, English artists decorated Canterbury, Westminster, Salisbury, and countless buildings throughout the land, but the civil wars, the coming of the Renaissance from abroad, the fall of the Church, and the growth of Puritan feeling, seemed to paralyse the development of native decorative art. No Pinturicchio arose here as in Italy, no Raphael to work with the architects in the adornment of public buildings. The Renaissance, instead of adding to our confidence and energy, seemed to condemn us as insular, to be without artistic knowledge, unworthy to paint frescoes. Little belief in our powers was shown by those in high places, by those able to commission and encourage. Was sculpture needed, or painting, the artists must come from abroad. Torregiano must make the King's tomb, later Rubens alone can paint the roof at Whitehall, just as Vandyck must paint the portraits. Verrio must paint the ceilings and walls at Hampton Court. Though, through it all, there were English painters, whose works we know, and many art craftsmen, the English artist was eclipsed by the superior skill of the foreigner. With the advent of Wren, the great English master, we find our countrymen again employed in important work, Streater in the Sheldonian at Oxford, and, still later, Sir James Thornhill at St. Paul's, and at Greenwich.

It has been said that the revival of letters 400 years ago, made it no longer so necessary that the walls of public buildings should furnish a literature for the people, and thus a great incentive to noble, historical, and allegorical painting died. Together with the sciences, the painters became learned and conscious. The naïvety of the earlier masters changed to greater care in exactness of representation, but with the old impossibility of the human race to do all things well and perfectly at one and the same time, their works lacked the simplicity and dignity of the earlier period. Architecture thought more of itself and less of the other arts which had previously combined with it to form an organic whole. If she used painting, it was more as a mistress employs a handmaid, and less as an equal co-operating with an equal, and painting apparently would have it so. Instead of covering wall surfaces with representations of noble deeds by great men, or pictures portraying the mightiness of virtue and the baseness of evil, as in the days of Giotto and Lorrenzetti, she wasted her powers, her perfect knowledge of technique, in extravagant flatteries of her employers, such scenes as we see Rubens painted for Marie de Medicis, the Apotheosis of James at Whitehall, and the foolish scene of Olympus, by Verrio, at Hampton Court. Can we wonder, when we see the purpose of painting reduced to these inanities, that the link uniting her to the great art of architecture would not bear the strain, or that we should have seen, as we have seen, painting and architecture widely separated, the one perfecting herself at the easel, and the other working experiments in the different styles?

We cannot imagine a more half-hearted, or more selfish condition of things, or one more contrary to the spirit of the great days of art. It is at any rate to the credit of English architects that they have all along recognised —and with much fulness of late—the harmfulness of the position.

On the other hand, we have also to notice that the Continent has never lost in the same degree as ourselves its interest or delight in the use of colour decoration. Changes not dissimilar to our own have taken place, but the arts of architecture and painting never lost touch one with the other as they did here. In Italy to this day a colour scheme in a new building has a prominent place. In France, a church, a mairie, or a theatre, even a railway station,* is not considered complete until it is painted in tempera or with canvasses, "marouflé," so that they form part of the building. Such conditions as these may also be found in Germany and Austria. England alone seems with but few exceptions to disregard colour as a necessary element of beauty in the designs of the interior of her public buildings.

What these exceptions are we may presently consider, but it is time to discuss the two divisions I have just mentioned, particularly with some regard to our work and practice at the present time. First, those buildings whose actual materials form a colour scheme. This is a method of decoration which was more in favour with the last generation of art workers, than it is with us at the present day. We are reminded of the buildings of the "Gothic revival," of the works of Butterfield and Street.

These buildings were the result, no doubt, of visits to Italy, where their prototypes may be found, also of a study of our own Gothic period, when a certain amount of parti-coloured wall work was done, brought to us by the mediæval current of art practice from east to west. Modern churches like All Saints, Margaret Street, and Keble College Chapel, by Butterfield, and the church in Garden-street, Vauxhall, by Street, are buildings of this type.

In process of time we seem to have largely passed away from this kind of work; it does not now seem so well worth doing, the results obtained were often cold looking, harsh, and mechanical, owing perhaps to the mathematical accuracy of modern building methods, but there was a principle underlying it all, one of value which cannot be lightly dismissed. We must remember, that when Butterfield did this work it was a great achievement, a launching out into new methods, a deliberate attempt at a human expression in art, and a clean break away from the (to him) cold and formal, dull and vacuous, interiors of 1845. Butterfield in "All Saints'" has done this, his first essay in the manner, with consummate skill and largeness of feeling, better than at any later time, and better than any of his imitators, and there were many who followed his lead. Few artists ever took such great pains or had such great gifts as William Butterfield. We must not think that he introduced this coloured work with the sole intention of breaking up the appearance of the wall surface. This was clearly not his main idea. With the "true principles" of the neo-gothic architect—and here I think we have the principle underlying so much of this work—his aim was to get a permanent wall decoration, one which would outlast the usually improperly made plaster wall covering. He recognised the difficulty and expense of securing any form of painted wall decoration, also the deleterious effects upon any painted surface of the fumes from gas lights and oil lamps, and the evilly charged atmosphere of London and our great cities. He set himself, therefore, to produce something which was suitable, lasting, and easily kept clean. He did this admirably. Take, for instance, the wall surface at All Saints, Margaret-street. First there is a dado of full colour some five feet high of tiles; above, large scenes from the New Testament painted on tiles. Above the arches of the nave arcade the wall surface is stone inlaid with bold patterning in tiles and dark inlay. On the east wall only is there any painting. Here are frescoes by Dyce in panels spaced between margins of alabaster. The roofs are vaulted and painted in the chancel, and painted wood in the nave. With the exception of the pictures on the east wall there is not a scrap of plaster in the church, and no one will deny that the scheme is interesting and good. In Keble Chapel there is a very similar scheme, but in materials more precious as befits a college chapel of such importance. Here the lower part of the wall has an arcading of stone, with the spandrels formed of coloured bricks. Above at a height of some ten feet from the floor are pictures, the subjects from the sacred history, in mosaic, and framed in stone. The pictures form a large and striking frieze running round the chapel; above it are the windows filled with painted glass, at some height, therefore, from the floor. Between and above the windows are more bands of coloured brick. The roof is vaulted, painted to represent stone. Here again, therefore, except in the painted roof, the ground of which I suspect is in well-made plaster, there is no plaster used, and the whole effect is one of great dignity. To our eyes nowadays such a method as this would require to be carried out on the broadest and simplest lines; we should also demand that the materials should be worthy. The black, white, and yellow bricks of 50 years ago have few charms for us now.

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* The new Gare D'Orleans, at Paris, which has two large wall paintings of "Biarritz" and "The Loire" in the waiting hall.

The system of alternations of colour in a wall surface, which no doubt had its origin—so much as came to us from the East—in the ancient Chaldæan and Egyptian worship of the universe, when by building their temples and pyramids in coloured stripes or courses, in due sequence and tints, they commemorated the heavenly spheres, fits in with the natural demand of the eye, which welcomes and recognises the propriety of variety in colour. It is open to us, therefore, to appropriately use the differently coloured stones we have, or our own native marble, while, thanks to the discovery and reopening of some of the old Greek and African marble quarries by men of energy and foresight like Mr. Samuel Brindley, of Messrs. Farmer and Brindley, ancient sources of supply are no longer closed to us. So long as we arrange the materials at our hand, be they of clay or stone, with breadth and simplicity, we shall be treating them with the dignity they deserve; and in buildings of importance we shall, I think, be treating ourselves with greater consideration if we invest our patterns with some meaning and intention.

Such principles as these, common to all forms of art, seem to be especially brought into mind when thinking of this form of treatment of a wall surface. In passing I may point to the Baptistery of Florence, San Miniato at Florence, the Church of the Miracoli at Venice, some late Roman examples at Ravenna, as being particularly successful examples of the use of marble in this connection. The cathedrals of Orvieto and Siena, are direct descendants of the striped work of the Saracen builders, a method of building common in the East to this day, and dating, as I have said, from her immemorial past.

The second division of our subject—"Those buildings which, on their completion, have been decorated in colour in a manner which makes that colour one with the materials of the building," offers a larger field for examination. It brings us into touch with the methods employed by our fellow artists the painters, and other art workers, and into notice the conditions which govern the employment of artists in these matters. I ventured to point out just now the different state of things 400 years ago in this country, compared with the present time. How that then nothing was more natural in most communities than a wide employment of painters and workers in the arts in the decoration of public buildings. The history of the past, and the examples remaining to us make this clear. What a contrast presents itself in our own time! Who, for instance, can read the story of the preparations for decorating the Houses of Parliament, 50 or 60 years ago, without amazement and astonishment at the ignorance of, and want of confidence in, the capability of the painters of that time by those in high authority. For some 20 years a Royal Commission was in existence, to consider and decide upon the best means of painting certain panels and rooms in the new Palace of Westminster. They instituted open competitions, invited cartoons, called for samples of painting in fresco. They doled out a few commissions. The expense incurred in preparing for these competitions and trials in painting must have brought many artists to the verge of ruin, and the many delays and slow procedure disheartened and crushed the spirit of all. If anyone wishes to read the sad story of these years, let me refer him to Redgrave's "Century of Painters," where the whole history is set forth by one who lived during the time, and knew it well. It may be that the government of our country is too complex and vast an institution to see the advantage of departing from the competition system, and to trust with commissions artists whose works and capabilities are known, the execution of which would add to the intellectual and artistic output of the country. The few examples we have of such a departure have been signal successes. I may refer, as an instance, to the employment of the late Lord Leighton in the frescoes, "Arts of War," and "Arts of Peace," at the South Kensington Museum.

Fortunately, the experience of the Houses of Parliament Commission I have referred to has served as a warning throughout the country to municipalities and to individuals; and it has been, no doubt, easier for municipal councils, who have so much power in their hands, to foster and encourage the arts of the country, and with their less cumbrous governing machinery, to avoid the many mistakes it is possible to make in the fit decoration of a building of importance. This is evident by the conspicuous success which has attended the efforts of some of the municipalities of the country. Manchester is most fortunate in having commissioned Ford Madox Brown to paint the scenes from her history in panels in her Town-hall. Glasgow is employing some of her own sons, Messrs. Henry, Lavery, Walton, and Roche, in her City buildings. The Corporation of Liverpool, acting wisely on the advice of their architect, has commissioned Mr. Charles Furse to paint the pendentives of its large dome, illustrating scenes from the commercial greatness of the city. Birmingham has commissioned some of the students of her Municipal School of Art to paint scenes commemorating her history in panels in the Town-hall. The Corporation of Colchester also, in the new Town-hall, on the advice of their architect, Mr. Belcher, is employing Mr. Charles Baskett to decorate the Council-chamber and Moot-hall, under his supervision and with his assistance. In London, in our own Royal Exchange, the Corporation of the City of London, together with some of the great City Companies, have commissioned artists to paint the panels of the ambulatory.

For some years past the municipalities of our towns have been fostering a love and appreciation for our arts by buying pictures and placing them in suitable galleries. This virtue of acquiring beautiful things has now been supplemented by giving commissions for mural painting. In the placing of these commissions, we have the greatest hope and encouragement for the future, and with the increase of the municipal councils which is taking place in our midst, we may look to see full advantage taken of the opportunities the public buildings present for the employment of artists of proved power and attainment, to the advantage of the people of this country. With this hope in our hearts, we may consider, with greater interest, certain of the methods of work which at the present time are in use.

Before speaking of different forms of painting available, I would like briefly to touch upon the possibilities offered to us by the use of marble, mosaic and plaster, stucco duro and sgraffito. These are so closely allied to the first division of the subject, that I would speak of them here. We know that the Egyptians, Greeks, and Romans used colour largely in their buildings, but we can have but little idea of the magnificent effects often attained by means of their fresco painting, encaustic painting, tempera, modelled plaster, mosaic, marble linings and veneering, bronze, ivory, gold and silver overlaying, and inlaying.

For instance, we read of the Golden House of Nero, that the walls were encrusted with gems and mother-of-pearl; of banqueting halls having ivory ceilings; of a ceiling in the State dining-room, which was spherical in shape, and cut in ivory to represent the constellated skies, and kept in constant motion by machinery in imitation of the stars and planets. This magnificence, inventive and symbolic, partook something of the marvellous and the rare, qualities which we have far to seek in this prosaic age. In their large halls, basilicas, and baths, it was also a custom of the Romans to line the walls with marble slabs to a considerable height, and above to use mosaic or plaster reliefs. The vaulted ceilings were generally coffered, and decorated in plaster reliefs, coloured and gilt; bronze rosettes were also used in the coffers.

These were general forms of decoration throughout the Roman Empire both in the West and East. We find them used by the Byzantine builders, in Constantinople, Sicily, and Italy, and we may be of opinion that few finer schemes of decoration have ever been devised. In some manner adapted to our modern needs they are available to-day, and it is understood that marble and mosaic are to be adopted in the new Roman Catholic Cathedral at Westminster.

In considering the use of mosaic at the present time, we may hope that the modern and vicious habit of preparing mosaic tesseræ face downwards on a sheet of paper laid on a flat table, and then pressing the sheet of paper into position on the wall has been finally given up. The old and only right method is to fix each tessera into the cement pushed in by hand from the front. Too many works of the last century are deficient in one of the most important elements of decoration, namely the right technique. Sir William Richmond in St. Paul's Cathedral, the largest example of mosaic work of modern times, has shown in the work which he has done there that there is no more trouble, and no appreciable loss of time in doing mosaic work in the only true way, viz., pushing it in, tessera by tessera, from the front. His assistants after very little practice have been able to do the work on these ines with the greatest rapidity, and naturally with intelligence and interest in seeing their work in position as it proceeds.

Time will not permit me to speak of modelled plaster and sgraffito in any detail, except to express the satisfaction we must all feel that these ancient arts of tried quality are understood and worked in a modern spirit to-day. The composition of stucco duro has been often described, and we know by the remains of ancient Roman work found in the Villa Farnesina, and of the works of the 16th century in the Loggia of the Vatican, and the Villa Madama, and other buildings in Italy and France, what exquisite possibilities this material presents. The work, particularly in the early Renaissance, was usually decorated in colour. This was generally laid on whilst the stucco was wet as in fresco, and the details heightened with tempera or encaustic colours, and accessories enriched in gilt gesso.

We may congratulate ourselves that artists like Mr. George Frampton, A.R.A., and Mr. Anning Bell have worked in this material in churches and other buildings in our time. The processes of stucco duro and sgraffito are fully described in the "Arts and Crafts Essays" published in 1893, the former by the late Mr. G. T. Robinson, and the latter by Mr. Heywood Sumner, whose work in All Saints' Church, Ennismore-gardens, affords an example of modern treatment. I need not do more than name these two forms of lasting decoration, peculiarly structural, and available to us to-day.

I may be blamed for not referring with greater fullness to the painted wall surfaces and roofs, of which there are many, in our modern churches. This work is raising itself above mere commercial expression, and under the direction, and with the co-operation of the architects of these buildings, we have instances by many painters of ability and knowledge.

If there is one thing which may strike us in this modern work as being different and inferior to the best work of the old time, it is a very general want of use of the full brush of colour carried through the work with bold and masterly sweep, avoiding thereby, in the necessary repetition of a pattern, the mechanical and accurate repeat so constantly seen in modern work, and never to be found in the old.

What makes so much ecclesiastical decoration of the present day so devoid of interest, is just this absence of intelligent handling. We are better without colour if it is not used in a manner consonant with its dignity. We may be sure its revenge on us will be ample if we use it in any other way, as much in the lowliest border or diaper as in the picture they may surronnd.

In our theatres and places of public entertainment, the same progress is, alas, not being made. The desire of the modern theatre manager to build a theatre, and to open it in six months, is against the production of anything else than a place in which plays may be produced. We are far behind the French in this matter. In Paris the foyers and staircases of the principal theatres are notably decorated by artists; so that the audience has the privilege of knowing that it is not in a mere box of upholstery, but in a temple devoted to the arts. I am inclined to think that were our theatres of the latter kind the interest of the audience in the art of the drama would be quickened and encouraged.

And now as to the principal methods in use by painters at the present time. Probably the world has never seen a more beautiful method of painting than Buon or true fresco, but, alas, its use has not been fully justified in this country. The Royal Commission I have just referred to, took a good deal of evidence as to its suitability for the decoration of the Houses of Parliament. A number of painters of eminence spoke against its being attempted. They advocated the use of oil colour. But the Commissioners, perhaps dazzled by what were then considered the triumphs of modern art,

—the frescoes at Munich, decided that the new paintings should be in that method.

Dyce, Cope, my father, and one or two others were successively commissioned. Exposed, however, to the bad air of their surroundings these works have, in some cases, suffered beyond repair. So doubtful were the painters themselves as to the suitability of the scheme, that when Maclise was commissioned to paint the walls of the Painted Chamber he, with the sanction of the Commissioners, proceeded to Germany in order to make researches into the practice of stereochrome or water glass painting. The result was that he adopted the process in the large wall painting, "The Meeting of Wellington and Blucher after the Battle of Waterloo;" it was also adopted by Mr. Herbert, who was then engaged on other wall surfaces in the palace.

You will permit me to remind you of what happens in Buon fresco. The powder colours mixed with lime water are applied to the last and freshly spread coat of plaster before it has had time to absorb more than a trace of carbonic acid from the air. The painting ground is in fact saturated with an aqueous solution of hydrate of lime, that is, slaked lime, while there remains a large reserve of this compound in an undissolved condition. When on such a surface a layer of pigment mixed with water is placed, as that water evaporates the lime water in the ground diffuses into the paint, soaks it through and through, and gradually takes up carbonic acid from the air, thus producing carbonate of lime which is the actual binding material.* The whole painting gains in this chemical action, appearing to absorb light and to reflect it from the sand facets of the ground to the spectator.

But, unfortunately, and here I again quote from Professor Church's interesting book "The Chemistry of Paints and Painting," "the protection afforded to the pigments by the binding material, this carbonate of lime, is not generally very efficient. In the case of a dry wall, free from soluble saline matter, and exposed to a pure atmosphere, it may remain good for centuries. But in air contaminated with the products of the combustion of coal and gas, and with tarry and sooty impurities, a fresco picture soon perishes. The binding carbonate of lime is converted into the sulphate, breaking up the paint. The same causes will form sulphate of magnesia from the carbonate of magnesia in the plaster, and the paint will scale off."

In our large towns therefore to-day, Buon fresco has no chance of lasting.

The stereochrome or water glass process consists in spraying the painting after completion, with a warm dilute solution of potash silicate, or potash-soda silicate, which is obtained by fusing the purest sand obtainable with carbonate of potash or carbonate of soda. The pigments themselves are mixed with some of the fixing liquid. This form of painting is a German invention of comparatively recent date; it has not been frequently used in this country, and we have very little experience of its behaviour.

In the consideration of the possibilities of tempera painting we find ourselves on surer ground, no longer so fearful of the consequences of the contaminated atmosphere of our towns. I am glad to be able to read you a few words I have received from Sir William Richmond, as to this medium which he used on the walls of a modern church at Cheltenham, a few years ago. He says:—

> "The wall was prepared with lime and sand, the final in tonaco was in marble dust and well-slaked lime, and it was wonderfully white. The whole design was drawn in charcoal, corrected with care. Egg, Capri wine and powder colours were used. The yoke of egg alone was used, plenty of wine and distilled water. The first painting should be in what the Italians called 'Verdaccio,' namely, raw siena (black and white), with plenty of impasto. In two hours this can be glazed with warm colour and painted into. I am quite certain that the yoke of egg and wine form the very best and most durable medium for wall painting. Most of the Italian wall paintings which have lasted, were not painted in fresco, but in the tempera of yoke of egg, the essential oil of which is a most powerful binding liquid, enabling the painting to dry like a rock."

Sir William further says:—

> "I prefer yoke of egg and wine, even to Buon fresco, the colour is almost as pure, not quite so light, and if it is necessary to get rich colour, the medium will give it to any extent."

Professor Church, speaking of the large amount of oil in the egg yolk says, "This vehicle does not act so effectually as oil and varnish in locking up pigments, and so the protection against change which it affords is less." But I think we may take it that the protection is certainly considerable, while the old method of varnishing the painting with sandarac in oil affords further protection against moisture and impure air.

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* I am indebted to Professor Church's "The Chemistry of Paints and Painting," for this description.

The well-known spirit fresco, invented by the late Mr. Gambier Parry, differs little from ordinary oil painting on account of the large quantity of oil in the copal, which forms so much of the medium, the constituent parts of which, I may remind you, are only multiples of these proportions, viz. :—

	ozs.
Gum elemi or elemi resin	2
Pure white wax (beeswax)	4
Oil of spike lavender	8
Finest preparation of artists' copal ..	20

With this medium incorporated by heat all colours in dry powder are mixed. It appears that Mr. Gambier Parry gave the name of spirit fresco to the method because oil of spike and turpentine may be freely used as liquids during the process of painting. The beeswax secures, of course, a perfectly matt, or dead surface, but it is liable to produce a kind of bloom in in the course of years, and may wholly disappear in the course of time.

Besides the paintings by Mr. Gambier Parry at Higham and Gloucester Cathedral, Lord Leighton's "Arts of War" and "Arts of Peace," at South Kensington, and seven paintings by Ford Madox Brown, in the Town-hall of Manchester, are examples of this method. They appear to be standing well, though we may expect them to darken, and there are a few signs of the bloom referred to above in the "Arts of Peace."

Professor Church considers that a sound medium is to be found in the proportions of—

	ozs.
Oil of spike	12
Paraffin wax	4
(The two mixed by heat.)	
Copal picture varnish	20

He advises the pigments being mixed in blown linseed oil, rather than in the medium itself, as Parry recommends.

I need not do more than allude to Parry's Ely medium. Briefly it is:—One part pale drying oil; one part strong copal varnish; two parts japanner's gold size; two parts turpentine, and the powder colours to be ground up in the medium. It is just oil painting over again with the gold size to give the necessary deadness of surface. He painted the eastern part of the nave, wooden roof, also the octagon and transept ceiling at Ely Cathedral in this medium.

I have dwelt on the component parts of these wax and oil mediums in some detail, as it is but a step from them to the method which is generally adopted by painters to-day. I refer to the prevalent custom of painting in oil on canvas, and then, on completion of the picture, having it fixed, or *marouflé*, as the French call it, to the wall or ceiling; that is to say, the canvas is fixed by means of a thick paste of white lead, oil and copal varnish, spread upon the wall and simultaneously upon the back of the canvas.

The French painters in the beginning of the 19th century, like their German brethren in Munich, painted mural works in fresco, but they were already beginning to discard the practice when we in our wisdom were working in it at Westminster. They also used encaustic painting (Delaroche's Hemicycle in the Ecole des Beaux Arts is an example), but since 1870 the most important works have been painted on canvas fixed in the way I have described; such are the great wall paintings by Puvis de Chavannes, in the Panthéon, in the museums of Amiens, Rouen and Lyons; the Sorbonne, and the Library in Boston.

This, too, is the method adopted in the Royal Exchange, at Liverpool, at Glasgow, and by Messrs. J. S. Sargent, R.A., and E. A. Abbey, R.A., in the Library at Boston.

Without going deeply into technicalities which would naturally vary with each painter, the colours used are simply oil colours, with a medium of wax and turpentine. Professor Moira, who has painted in this way at the New Renshaw-street Chapel in Liverpool, and at other places, tells me he likes the canvas to be fairly coarse and open, so that there should be no hindrance to the fixing material incorporating itself with the colours laid on. This is better achieved by doing the first painting only in the studio, and completing it *in situ* after it has been fixed upon the wall, or ceiling. The painting of the picture *in situ* in this way will I am sure commend itself to all as a most important side of this system of decoration. It is understood that some of the modern works I have named have been painted entirely in the studio; corrected in many cases no doubt when in position. But as a practice it must surely carry with it its own condemnation. Although scale drawings and models may be made with the utmost care, and cartoons in full size tried in position, all of which should be done, and invariably are done before the painting is begun, unless the work, or at least the major part, is carried out in the building, it is not possible for the painter to be confident as to the correctness of his scale, or what is more important in its difficulty, of his colour. Both these elements, more particularly the last, must surely be influenced by the size and lighting of the building, an intimate knowledge of which is revealed by working in it. Are we to suppose that the ceiling of the Sistine Chapel would have been as magnificent as it is if it had been painted by Michael Angelo in a studio and then fixed in position? I confess the very thought is sacrilegious, and I tremble at suggesting it.

In this connection, I am reminded of a painting on canvas, in St. Alban's, Holborn, which was painted chiefly on the wall, where by its position in a dark corner of a church, certain colours had to be used which are startling in what would be their inappropriateness in a better light. For instance, in order that the hair of the Saviour, one of the figures in the composition, should appear brown, pure vermilion had to be largely used; ordinary light brown appeared black.

But it is unnecessary to multiply instances, and I would venture therefore only to suggest that as in most cases the position of the painting directs the colour to be used, it is desirable that it should be as far as possible painted *in situ.*

It is to be hoped that the convenience of this modern method of painting on canvas will not deter painters from working directly on the plastered wall in tempera, oil, or encaustic. If the beautiful qualities of fresco are denied to this country, there are yet the qualities inseparable from a plaster ground, which a canvas surface can never present, in the same way.

Design I need not touch upon. There is no excuse for bad work, surrounded as we all are by the highest examples. A fine translation of modern life appears to be growing in mural painting of the great type, and is heartily to be welcomed. In this connection, I would draw attention to Mr. Furse's work at Liverpool, and some of the work at Glasgow, while in allegory, we have the great work of Mr. Sargent at Boston. In setting ourselves a standard we may remember perhaps the words of Puvis de Chavannes: "Toute décoration ne peut être belle que dans la mesure où elle reflète la Nature et en traduit la passion."

DISCUSSION.

The CHAIRMAN said that Mr. Horsley had given them a very comprehensive sketch of a very large subject. It certainly seemed to him (the Chairman) as if English people had almost ceased to regard art as of very much public importance, or as an important means for the expression of national thought and aspiration, to say nothing of history and the idealising of daily life. In that sense Mr. Horsley made an interesting point when he spoke of the decline of fresco painting and the decoration of churches and public buildings, upon the incoming and popularisation of literature and printing, and the multiplication of books. He (the Chairman) was strongly of opinion that the painted walls of the public halls and churches in the middle ages acted in a great measure as public libraries, or were a sort of equivalent for them, through presenting before the public the great facts of religious and national history, symbol and legend. He regretted that Mr. Horsley had not been able to secure specimens of the very interesting series of wall decorations by Madox Brown at the Manchester Town-hall. Most of the illustrations which they had seen were of French origin, or showed French influence, but the designs of Madox Brown were characteristically English, and showed remarkable dramatic sense and vivid power of conception, with a certain naturalism and local truth of detail, giving one the sense that the artist had been an actual spectator of the historic scenes he depicted. He entirely agreed with Mr. Horsley in thinking that there was an immense advantage in working upon the painting *in situ* and painting in the light in which the work was to be seen: but there was also a great practical disadvantage because the work was generally built in by scaffolding, and the artist was never really able to get away and take a fair view of it before the scaffolding was removed. Barring that disadvantage, there would, perhaps, be better results if mural decorations were painted *in situ.* It was related that Mr. Watts made an offer to the London and North-Western Railway to paint the walls of the great hall of Euston Station if the company would be answerable for the cost of the materials, and that the offer was declined. That was, perhaps, an indication of the way in which public art was regarded. At any rate, it would appear the company did not wish to detain people in the hall of the station, but wished to hurry them forward to take their tickets for their destination. Perhaps many of them might have missed their trains if the painting hed been carried out. He was quite in accord with Mr. Horsley with regard to tempera. He thought that tempera was a medium presenting few if any technical difficulties, and having very great resources and advantages, including the advantage of durability. He did not think that Mr. Horsley had said very much about tile decoration generally. Possibly that might be regarded more as an external decoration, but he had often thought that more might be done in the way of glazed or terra cotta relief in the method of the Della Robbia ware as decoration. Certainly such bold effects of colour and brilliant white associated with that material were perhaps more suitable in the open air and in inner courts and places where reflected light was required, and, even there, associated with mural and architectural design of a particularly light-toned character. As a rule, when it was applied in this country it seemed to be in glaring contrast to the colour of the materials of the building.

Sir THOMAS WARDLE said that, as a member of the Applied Art Committee, he had advocated the proposal that a paper should be read on the decoration of the interiors of public buildings, and he associated with the subject the name of his friend Mr. Horsley, of whose work he had had some experience in North Staffordshire. They there had some of Mr. Horsley's work as an architect, and it was no small pleasure to find that when Mr. Horsley suggested colour decoration for his church architecture there, he had given them a series of paintings without which the churches in which he had worked would be bare indeed. He remembered going on several occasions to speak to him during his work at All Saints' Church in Leek, and he found him generally lying on some planks in the top of the chancel almost invisible, but completely devoted to his work. The results of that work were very pleasing and excellent. This subject had been introduced to remove the prejudices of people. Many people in the land seemed to prefer a plain building to a decorated one. When he (Sir Thomas Wardle) advocated the subject, he did so more with regard to places of worship, as to which he had spoken in two or three papers which he had read. He had often been very much pained on going into churches and chapels, to see the utter absence of decorative work; the worshippers in such places feeling that the buildings were better without decoration. That feeling had perhaps descended from the old Puritan times, but he believed that it was passing away. He might instance a Nonconformist chapel in Ashton-under-Lyne, where there was one of the very best windows by Sir Edward Burne Jones and William Morris. The more that window was seen, the more it was appreciated. The same might be said of Scotland, where artistic influences are rapidly becoming general. He thought that good would be done by such a paper as Mr. Horsley had read. England was now paying much attention to art and colour, and we might well rise superior to prejudice and avail ourselves of the skill which lay at our hands. In his town there was a rather amusing difficulty. Some years ago, his dear friend, the late John Sedding, designed a reredos for Saint Luke's Church. It was an admirable piece of work and consisted in part of sculpture. The design was a coloured one, and the Puritan spirit of the town rose against the colour. The people did not object to the figures or to the marble, but they objected to the figures being coloured. He begged that the pictures should be painted in distemper that it might be seen how they looked; and no sooner had that been done, than the whole congregation were pleased with the result. It had now become necessary to clean the reredos and repaint it, and it was to be repainted in colours as the architect designed it. Now, unfortunately, the old spirit had risen up again, and the parish was rent in twain, and some had objected to the painting being done. Papers like that which had just been read might be well directed against such weak and ignoran prejudices. They had only to look at the beautifu room in which they were assembled to see the value of decorative work. He was sure that the decoration in the Town-hall of Manchester, to which the Chairman had alluded, had had a great effect on the minds of the majority of the people in the district At Cheadle, in North Staffordshire, there was a church built by Pugin the Elder, who decorated i from end to end. It was built about 45 years ago and it was one of the most beautifully decorate churches he had ever seen in his travels either in this country or on the Continent. He did not think that there was a square foot that was not decorated or painted.

Mr. T. R. SPENCE said that all the materials that Mr. Horsley had advocated in his interesting paper were extremely good in their way. There was, however, the great question of design. There was a very glorious example of colour treatment in marble and tiles which Mr. Horsley did not mention. He referred to the mosque of Omar in the temple area in Jerusalem The whole of the outer walls of that building up to the eaves of the side chapels were covered with a very beautiful arrangement of various coloured marbles. The outer part of the wall which supported the dome was covered with most beautiful Arabesque tiles, and, of course, the effect of the marble and the tiles together in the beautiful Eastern light was beyond description It seemed to him that in decoration in England we were too much afraid of colour. His view was that the more effulgent the colour was the finer was the result. He strongly advocated that the various tones of colour should be rich and effulgent, and not limited to the pale greys and shabby greens which had been very much used in recent times.

Mr. W. WOODWARD thanked Mr. Horsley for his very interesting and very valuable paper. He hoped that the paper would do some good in inculcating the idea that English artists were quite capable of successfully decorating English buildings. With regard to Mr. Butterfield's work at Oxford, he was sorry to differ from Mr. Horsley in his commendation of that work. He must confess that when, some quarter of a century ago, he visited Keble College, at Oxford, he thought that not only architecturally, but decoratively, Mr. Butterfield had imported into grand old Oxford something which was antagonistic to its associations. Two years ago he visited the place again, and he found that the effect of time, that grand adjunct of art, was evident in Mr. Butterfield's work. Time, as they all knew, did an immense amount of good for all art, and particularly with regard to architecture. He had been very glad to hear Mr. Horsley speak of the mosaic work in St. Paul's Cathedral.

One had only to look first at Sir William Richmond's work and then carry one's eye to the work of Salviati in the dome to see how very much more effective was the work of Sir William Richmond than the work of Salviati. Mr. Horsley had referred to the importance of the architect and artist working together in sympathy. They would all agree in his view in regard to that point, but he was sorry to say, that in a recent work of his own in which he had expended very considerable care in detail, the decorative artist acted upon his own initiative and produced a result which displeased him (Mr. Woodward) very much. But if the sentiment that Mr. Horsley had expressed was carried out, there could be no doubt whatever, that our public buildings would be far better decorated, and far more presentable, than they were now. In speaking of mural decoration, Mr. Horsley had omitted to mention a work, which appealed to everyone who had seen it—Lord Leighton's lovely representation of the Wise and Foolish Virgins, at Lyndhurst. That was, he believed, one of Leighton's earliest works. With regard to the materials, marble and mosaic of course had the advantage that they did not require restoration or re-doing, but he must confess, that marble and mosaic in London, unless they were kept perfectly clean, and had some attention paid to them, suffered considerably in the course of a very few months. A very fine effect was produced by simple cleanliness, and this was needed in external decorative work in London. There was another matter with regard to London decoration, which Mr. Horsley had not mentioned, and that was the attempt made some years ago, by Messrs. Novello, in their music establishment in Berners-street. It was an example of external decoration which looked exceedingly well, but it had suffered from the effects of the London atmosphere.

Mr. PHENE SPIERS said that the address was one of a most interesting kind, but it was certainly not in accordance with the title given of the subject. He had anticipated a paper on the necessity or advisability of accentuating the constructive features of buildings by colour decoration. That was a point which he hoped Mr. Horsley would take up on some future occasion, for it was of the very greatest importance. It had been brought to his mind this evening by two of the slides which had been shown of Colchester Town-hall, in which Mr. Belcher had been able to accentuate the constructional forms of the designs by the colour decoration which he had used. If an artist was brought in whose views were not in harmony with those of the architect who had not considered the buildings from the architect's point of view, and who failed to understand the constructional features, he would be quite liable to contradict the constructional forms by the decorations which he put in. Therefore he thought that the colour decorations of a building should be conceived from the first, and that the work which the artist did eventually should be done with an understanding of the design of the architect. A totally wrong effect might be given by calling in an artist who did not understand the scheme of the architect's work. Referring to the opinions expressed as to the method of fixing mosaics, he was talking the other day with the artist who had designed the mosaics for the Albert Memorial, and who said that he was of opinion that if an artist was employed in putting the tesseræ down on the face of the drawing, the question of putting them up in their position and the waving of the various faces of the cubes could be easily managed, and he spoke very strongly in favour of that system of work, and alluded to an example in which superior results had been arrived at by adopting that method. He (Mr. Spiers) only mentioned that incident to show that there might possibly be two points of view.

Mr. C. BASKETT said that as Colchester Town-hall had been alluded to, he might state that he was the person who decorated it, and he was pleased to say that the architect and he were working together in every way. When he (Mr. Baskett) took up the design, he tried to enter into the spirit of it. He considered it the duty of a decorator when an architect was in charge, to try and enter into the spirit of his design. He had endeavoured to do so with Mr. Belcher, and the result was harmony and success in work. Mr. Horsley had alluded to damp walls. Twenty-five years ago, he (Mr. Baskett) had had to decorate a church wall that was exceedingly damp. A few months after the work had been done, it had perished. In order to meet the difficulty, he had some lead rolled very thin, about 3 lbs. to the foot, and cemented it upon the wall. The lead was painted, and stippled, and it became a beautiful surface to work upon. He was at the church a few weeks ago, and the work was in as good a condition as at first, but the work which had been put on a wall close by, which was considered dry and safe, was altogether gone. It had struck him that the meeting might want to know how the difficulty was dealt with. After the lead had been applied to the wall with cement, made with pitch, mixed with a little tallow, it was ironed with hot irons to ensure cohesion, and it had stood thoroughly well.

Mr. G. C. HORSLEY, replying, said he thought that they had had a very interesting discussion. It included points upon which naturally he was unable to touch in a paper such as that which he had read. The subject was a very large one, and opened up many avenues for consideration, and it had been impossible to touch upon more than a very few. What had been said by Mr. Spiers, as to the necessity of the decorative designs of a building being in sympathy with the construction and expressive of the construction, formed a valuable supplement to the paper. At the same time, that was a point which must depend very much upon the painter and his consultation with the architect; and he conveyed in his paper that if there was no proper sympathy between the architect and the painter, that is to say, a thorough knowledge of each other's work—in short, a knowledge of art—there could be no good decoration. It was a subject upon which all architects felt very much. He was very much obliged to Sir Thomas Wardle for what he had said about prejudice against employing artists in decorating buildings. If people had a little more confidence in artists and a little more desire to see what they could do, they would be better pleased. The prejudice against artists was a thing which they must try to overcome; the public must be educated as to that matter. Sir Thomas Wardle had spoken of the effect of the fine paintings of Madox Brown in Manchester. He (Mr. Horsley) regretted that he had been unable to obtain any photographs of them. He had nothing more to say except that he thanked the meeting very much for the way in which they had listened to his paper. He knew that it was an exceedingly inadequate production and dealt only with one or two sides of a very large and most interesting question.

Mr. J. D. CRACE writes:—Much to my regret I was prevented by illness from attending to hear Mr. Horsley read his paper. It was a matter of great disappointment to me on reading a proof of the paper to find the title practically passed by in the contents. Here is an architect of great ability and high position, with a subject of intense interest and importance to architects, "Structural Colour Decoration," actually making no reference whatever to the effect of colour on structure, the one side of the subject which vitally touches the work of the architect. There are passing references to coloured materials such as marbles, mosaic, bronze, but no word as to how the placing of these affects the structural impression of the whole for good or evil. What does it matter to the structural effect whether the pictorial work on the walls is painted in "tempera," in "spirit fresco," or in "water glass." The architect himself, a few yards distant, could not tell which had been used. The "vehicle" is of consequence to the painter, of none to the architect. But "Structural Colour Decoration," that is to say, the disposition of colour as affecting the structure, does deeply concern the architect. It is this part of the subject to which I had hoped that an architect of Mr. Horsley's ability would have devoted most time and attention, for it is not only the part which most concerns architects, but, unfortunately, it is the one of which they overlook the value. I have read and listened to dozens of papers by architects on the technique of mosaic, of fresco, of encaustic painting, of marble and woodwork, "sgraffito," plaster, and other decorative methods and materials; not one, that I can remember, on their disposition as influencing the structural effect. Methods and "technical tricks" are all very well, and are good for the practitioner to be familiar with; but it is the distribution of the colour masses and colour values which affects the architecture. It matters little to the effect of the building (as architecture) whether the wall paintings represent the "Siege of Troy" or the "Jubilee Procession," or whether either be painted in "tempera" or "true fresco;" but it matters everything whether these works are so placed as to make the columns look thin, or so coloured as to disturb the perspective, or so isolated as to remain disturbing patches. It is of much more consequence to the architect that the general scheme of colour should be founded on recognition of the structural lines, that the colour values should be in the right places, and that the borderings and other ornamental features should be arranged, not with a view of "breaking up the wall surface," but with careful consideration of their effect in expressing or explaining the surface, and in assisting the perception of structure. So far as it does this colour glorifies a building; where it does not do this it abases it as architecture. A wall painting may be full of admirable skill, and yet be absolutely detrimental to the architecture which encloses it. Until architects will recognise this very plain fact, and will devote more attention to the influence of colour on structural effect, leaving aside the technical questions which, after all, more concern the executive artist, we shall obtain no real alliance of the Arts. Let the architect get to know how colour will affect his work, where it should be used, and why, and he will find the painter much more ready to listen to him than when discoursing of how to put it on.

General Notes.

GOLD IN VICTORIA.—The gold yield of the State of Victoria during the first two months of 1902 is reported by the Agent-General to amount to 96,409 ozs., the yield for February being 57,318 ozs. as compared with 54,625 ozs. for February, 1901.

MEETINGS FOR THE ENSUING WEEK.

THURSDAY, APRIL 3...Linnean, Burlington-house, W., 8 p.m. 1. Mr. Spencer Moore, "The Composite Flora of Africa." 2. Prof. F. E. Weiss, "Lepidophloios fuliginosus."

Civil and Mechanical Engineers, St. Ermin's Hotel, Westminster, S.W., 8 p.m. Mr. Edwin Ault, "The Ventilation of Drains and Sewers."

FRIDAY, APRIL 4...Geologists Association, University College, Gower-street, W.C., 8 p.m. Prof. H. A. Miers, "Klondike, its Geology and Mining."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Tuesday, April 8, 8 p.m. (Applied Art Section.) Professor Beresford Pite, "Street Architecture."

Wednesday, April 9, 8 p.m. (Ordinary Meeting.) Major-Gen. John F. Crease, C.B., "Ceuta and Gibraltar."

Further details of the Society's meetings will be found at the end of this number.

Proceedings of the Society.

INDIAN SECTION.

Thursday, March 13, 1902; Sir Antony Patrick MacDonnell, G.C.S.I., in the chair.

The Chairman, in introducing the reader of the paper, said that in India before an Indian audience it would not be necessary to introduce him, inasmuch as for many years he had been associated with the temperate, accurate, philosophical, and at the same time sympathetic treatment of agrarian and economic questions in that country. No one was known to be more competent to deal in a befitting manner with this great question upon which he had undertaken to write, and he (the Chairman) felt sure that all present would benefit by Mr. Holderness's exposition of the subject.

The paper read was—

THE INDIAN FAMINE OF 1899, AND THE MEASURES TAKEN TO MEET IT.

By Thomas William Holderness, C.S.I.

I have undertaken the preparation of this paper on the Indian Famine of 1899-1900, with considerable misgiving. In the first place, the subject is so large, and the questions involved in it are so many, that any satisfactory treatment of it within the ordinary limits of a paper is difficult. In the second place, the report of the recent Famine Commission has been read by everybody who is interested in Indian economic questions, and their conclusions and recommendations are so succinctly and clearly stated, that it would be a work of superfluity to restate them at length, while I should be very sorry to set myself up as an independent authority on controversial points on which the Commission has given their verdict.

If, however, we take the report of the Famine Commission and examine its structure and its contents, we find that it has certain limitations, which were imposed upon it by the terms of the order of reference. The Commissioners themselves point out that their mandate, though large, did not embrace the management of the famine by native States, and that the whole question of irrigation works had been remanded to a separate Commission for special investigation. Moreover, the Commission did not consider it within the scope of their instructions to present a consecutive narrative of the famine. They state in very broad outline the circumstances with which they had to deal, and they then proceed to re-state, with reference to these circumstances and to the various incidents of the struggle, the general principles by which alone famine relief, on a great scale, can be successfully administered. They assume, as unquestionably they were right in assuming, that the Government of India, to whom their report is addressed, and the Provincial Governments, for whose guidance their recommendations are made, are fully informed as to the causes and extent and intensity of the famine, and as to the particular course of the relief campaign in each province. If a person should desire this information, he must fill in from other sources "the broad outlines" which for the particular purpose of the report are no doubt sufficient.

It has, therefore, occurred to me that the most useful line which I could pursue in the present paper would be to go outside the limitations which were imposed on the Commission, or which the Commission imposed on themselves. I propose, therefore, in the first place, to describe briefly the circumstances of the drought which fell on India in 1899, to give some idea of the extent of territory in British India and native States which was affected, and to estimate very roughly the losses inflicted on the agricultural population. Secondly, I propose to place before you the leading features of the problem of famine relief as it presented itself to the Government of India, to the several local Governments, and to the chiefs of native States in the autumn of 1899, and to give a brief and necessarily a very general sketch of the course of the famine, and of the operations undertaken to combat it. Thirdly, I shall indicate the nature of the findings of the Famine Commission, and the general character of their recommendations. And, lastly, I have a few words to say on the question of famine prevention or protection.

I. THE LIABILITY OF INDIA TO DROUGHT.

It is almost a truism to explain that a "famine" in modern India no longer denotes an absolute dearth of food. Thanks to improved communications, and to the development of irrigation in Upper and Northern India by means of perennial canals drawn from snowfed rivers, food is always procurable in the country, though it may have to be brought long distances if the harvests locally fail, and may consequently be dear. By "famine" is now meant the severe and widely-prevailing distress which is produced among the agricultural population by a general failure of the crops over a large area, which at once diminishes the local supplies of food and deprives the great majority of the people of their means of livelihood. When any event happens in a manufacturing country, such as England, which throws the operatives in any large industry out of work, we know from experience that great and general distress ensues, that poor-law relief is greatly expanded, that employment for the able-bodied has to be extemporised, and that every kind of charitable agency has to be appealed to. Now, the great industry of India is agriculture. The wealth of India lies in its crops, its flocks and herds. Every man's eggs are in one basket, and that basket is exceptionally liable to sudden disaster. From geographical and physical causes the agriculture of India in the main is, and will always remain, dependent on the annual rainfall; and that rainfall coming, as it does, from the Indian Ocean and from the tropical regions of the southern seas, is unfortunately not a certain quantity, but varies according to the strength or weakness of what we, in our ignorance of the ultimate laws of meteorological phenomena, call the "monsoon current." The Indian continent is, therefore, always exposed to the contingency of a failure, more or less extensive, of the summer rains; and as two-thirds of the population depend on agriculture, the economic condition of India is always precarious. So far as we possess authentic knowledge of its past, we find that good and bad cycles of rainfall have alternately prevailed. From 1877, when the great drought which caused the Madras famine of that year finally broke up, to 1896 a good cycle prevailed, and extensive drought or widespread distress was unknown. Since 1896 a very bad cycle has prevailed, marked in 1896-7 by a drought as extensive and intense as that of 1876-7, and again marked in 1899 by a still greater and more intense drought, causing the famine which is the subject of this paper. It is essential to bear in mind this cyclical feature of the rainfall of the Indian continent, because it explains the apparent paradox of an India which, in the opinion of competent observers, is on the whole advancing in prosperity, and an India which in 1896 and again in 1899 was throughout vast regions desolate and famine-stricken. If these cycles of prosperity and adversity are overlooked, the doubt may well arise whether the terrible distress of 1896-7 and again of 1899-1900 is not an indication of an exhausted country and of permanent *malaise*. The only way to allay this doubt is to show that this distress was the product of special causes, that the causes were potent enough in their destructive capacity to account for the distress, and that, so far as can be predicted, they are exceptional in origin, and occur only at considerable intervals of time. No one can deny that a drought, such as that of 1896 or 1899, grievously impairs the prosperity of the afflicted districts. Nor can it be doubted that if India were to experience a permanent succession of years such as it experienced from 1896 to 1900 its condition must deteriorate. This is merely to state the obvious truth that the difference between India and the Arabian desert is at bottom a matter of the rainfall. If the hitherto existing standard of rainfall in India were to undergo a large and permanent reduction, a great part of the continent undoubtedly would drift into the condition of sterile

Arabia. Theoretically, the material declension of India is conceivable, and no human power, nor the most perfect government in the world, could in the supposed circumstances arrest its decay. But this contingency, to my mind, is far more remote than the exhaustion of the coal-beds of England. I consider that although we may be ignorant of the ultimate causes which govern climate and rainfall, the past history of India warrants the belief that India has always been exposed to cyclical periods of drought followed by long periods of agricultural prosperity, and that we may confidently expect an early return of the normal conditions of climate.

II. The Drought of 1899.

I pass now to the consideration of the character and effects of the drought of 1899. I propose to show, in the first place, the extent to which the rains failed in that year, and, secondly, to describe briefly the losses which their failure inflicted on the agricultural population. If we can satisfy ourselves as to the magnitude of these losses, and as to the exceptional character of the cause which led to them, we may, I submit, put aside the apprehension that the melancholy and deplorable distress of which India has lately been the scene is the direct result of deep-seated economic ills, or denotes a permanent decline in the productive power of the country. Now, what are the facts as to the rainfall and the harvests of 1899? They are these. The mean average annual rainfall of India for the last 25 years and for the whole continent is 41 inches. In some areas the average is much higher than this, in others it is less; but the mean average annual rainfall for all registering stations is 41 inches. In a most valuable memorandum published in 1900, Mr. John Eliot, the accomplished head of the Indian Meteorological Department, has shown that between 1875 and 1895 there were only three years in which the mean rainfall of India was below this average of 41 inches by more than 3 inches. Two of these were the years 1876 and 1877—the period of the great Indian famine—when the deficiency was respectively 4·49 inches and 4·28 inches. The third year was 1891, when the deficiency was 3·54 inches. Then we come to 1896, the year of the great famine of 1896-7, when the deficiency was 4·83 inches. But when we come to the year 1899, we find that the deficiency was no less than 11·14 inches. Mr. Eliot's conclusion from these and other data, which I need not reproduce, is that the drought of 1899 was the greatest in extent and in intensity which India has experienced during the last 200 years.

The figures which I have given represent the aggregate result of the returns for the 56 rainfall divisions into which India is divided, each of which contains many registering stations. If we examine these divisions one by one, and confine our attention to the rainfall between the 2nd July and the 14th October, which is the critical period for the two great harvests of the year, we find that in 16 divisions the rainfall of 1899 was from 60 to 100 per cent. in defect; in 13 other divisions it was from 25 to 60 per cent. in defect. In short, outside Burma, Bengal, and the eastern half of the North-West Provinces and Oudh, the rainfall was everywhere deficient, while over an enormous area the deficiency was so great as to cause general destruction of crops and fodder, bring agriculture to a complete standstill, and convert the lands for months into a parched and waterless desert. Three-fourths of the Bombay Presidency, practically the whole of the Central Provinces and Berar, the greater portion of the Punjab outside the charmed belts of perennial irrigation, lay under this terrible drought, which also engulfed an even greater extent of native territory, extending from Hyderabad in the south, through Rajputana and Central India to Kathiawar on the west, and to the sub-Himalayan State of Patiala in the north. The livelihood was imperilled, and the agricultural capital wasted of many millions of people. The official estimate is that the drought was intense over 175,000 square miles in British India, with a population of 25,000,000, and in native territory over a further area of 300,000 square miles, with a population of over 30,000,000.

I find it impossible to estimate with any accuracy the loss of crops and agricultural stock occasioned by the drought. I shall, therefore, content myself with a few illustrations of these losses taken from the published official papers on the famine.

In the Bombay Presidency, including Sindh, the normal production of food grains is about 5,500,000 tons worth, say, about £22,000,000 sterling. In 1899-1900, the production was under 1,500,000 tons, of which half came from the irrigated tracts of Sindh. The Guzerat districts ordinarily yield 1,000,000 tons; in 1899-1900 they yielded less than 50,000 tons. The Deccan districts ordinarily yield 2,000,000 tons; in 1899-1900 they yielded only 300,000 tons, The normal food-grain production of the Central Provinces is about 3,000,000 tons. In 1899-1900, the yield for the province was barely one-fourth of this, varying from one-tenth in the worst districts, to one-third in the Nerbudda Valley. In the previous famine year, 1896-7, when the Central Provinces suffered very severely, the deficiency did not exceed one-half for the province as a whole, while in one district only did it exceed two-thirds.

In Berar there was a complete failure of the autumn crops. Little or no spring crops were sown, and most of what were sown wholly failed. The normal food production is about 1,000,000 tons. In 1899-1900 it was under 50,000 tons.

In the Punjab the crop failure in the east and central districts was equally complete on unirrigated lands, though distress was localised by the magnificent system of perennial canals.

Bearing in mind that in all these provinces the cotton and other valuable non-food crops were also destroyed, and that in many other parts of British India the harvests were short, the official estimate which computes the crop losses of British India in 1899-1900 at about £50,000,000 sterling is, if anything, under the mark.

The crop losses in native territory must, in the absence of detailed agricultural returns, be largely a matter of conjecture. The area and the population affected by drought were larger than the drought-affected area and population in British India. On the other hand, agriculture is subordinate to pastoral occupations throughout the greater part of Rajputana and Central India, and, generally speaking, the standard of cultivation in native territory is below that of British India. We may, perhaps, venture to put the crop loss in native States, in 1899-1900, at about £30,000,000 sterling.

No reliable data exist for estimating the losses of cattle and live stock. They are known to have been enormous. In the more favoured tracts the more valuable cattle were saved by the devotion and self-sacrificing care which the Indian peasant bestows on his treasured animals. This was the case in Berar, and in many districts of the Central Provinces. But in Guzerat, and in the arid plains of the South-East Punjab, even this consolation was denied the cultivator. The renowned herds of these tracts have almost disappeared, and, in comparison with this disaster, the loss of a year's crops becomes insignificant. Rajputana is believed to have possessed between 13,000,000 and 14,000,000 head of stock. Of these, more than half are said to have perished. In one State the losses amount to 90 per cent., and in fonr others to over 70 per cent.

III. THE RELIEF PROBLEM IN THE AUTUMN OF 1899.

The drought which I have described settled upon Central and Western India early in July, 1899, and grew and spread as successive weeks passed without sign of rain. Premonitory symptoms of coming trouble were seen in the great migratory movement which commenced in Rajputana and in the influx of starving wanderers into the towns of Guzerat. By October the fate of the crops was sealed, and prices of all food-grains rose sharply throughout India. At Ajmer, the administrative centre of Rajputana, wheat went up to 16 lbs. the rupee, which in the preceding May had been selling at 28 lbs.: and barley was at 18 lbs. against 40 lbs. in May. This sudden rise had the useful effect of drawing ample supplies from other parts of India, from Burma, and even from America. I myself saw in October, samples of American wheat in the Ajmer bazaar which was being offered for delivery there at 16 lbs. the rupee. But there was grain enough in India to keep prices below the point at which extensive import from abroad would be possible; and the October prices reflected the temporary panic of the grain-trade, and were not maintained. The railways again demonstrated the ease with which the failure of the harvests over part of India is now made good from other tracts, and the ability of private trade to carry out the operation without the direct intervention of the State. In the first days of the 1896 drought, when prices rose with similar rapidity, and the grain markets of the country were temporarily disorganized, Lord Elgin's Government had to resist the well-meant but shortsighted importunities of the public and the press, urging the Government to avert disaster by importing grain from abroad, or by granting a bounty on imports, or by laying an embargo on exports. The policy of non-interference proved, on that occasion, conspicuously successful, and to its success may be attributed the fact, that no similar apprehensions were expressed in any quarter in the late famine.

It may be asked, where did the grain come from. There were evidently considerable stocks of grain in the country, and these were freely drawn upon. Old grain pits were uncovered, and big stacks of rice were opened and prepared for the market. High prices are better than a magician's rod for drawing food from unsuspected sources and revealing the existence of hoarded wealth. As time went on, these stocks were re-enforced by the harvests of the year in the fertile plains of Bengal, where the rains were favourable, and in the irrigated tracts of Upper India, and production was stimulated to the utmost by profitable trading. "Another year of famine," said a sturdy peasant in a canal-village, "and we Játs will all be rájas." Burma too came into the Indian market, and diverted to India the surplus rice which ordinarily goes to other countries. In eighteen months it poured into India about 1½ million tons of its staple product. In the Behar famine of 1873, Burma rice was rejected by the people as unwholesome, if not indeed unclean, coming as it did from beyond the "black water." In the late famine, this despised food found its way into remote villages of Rajputana, and was everywhere accepted with thankfulness. In 1868 there was absolute starvation in Rajputana, because the cost and difficulty of transport from the granaries of Agra made import impossible. In 1899 Rajputana was fed from Burma, from the Punjab, and even from Madras, with ease. I know of no more signal proof than this of the incalculable benefit which India has derived from the extension of the railway system, and yet we hear from time to time that railways are the ruin of the country, and that the money spent on them should have been put into canals. Why, a canal is useless until there is a railway to convey its produce away. The first thing that had to be done the other day when the Chenáb canal colonies were founded, was to build railways to connect them with the outer world.

To return to the famine. In October it was apparent that relief would be necessary on a very large scale in British India and in native territory. It will be convenient here to describe the difficulties of the problem.

In British India, the general line of action admitted of no doubt. There was money, there was organisation, and there were well recognised principles and methods of relief, carefully adapted to the varying requirements of the people, and to the special needs of all classes and all ages. These principles and methods of relief have been elaborated into minute rules known as Famine Codes, which I do not propose to discuss, though I may briefly mention the essential points. These are—(1) The formation of a complete and quick-working system of famine intelligence, based on the indigenous institutions of village headmen and accountants, and drawing into its finely woven meshes every particle of information likely to be of value to the directing authorities: (2) the offer of work of a simple manual character, such as earthwork or metal-breaking, to every one able and willing to labour, at a wage sufficient to maintain the labourer in health: (3) the bestowal of gratuitous relief, based on local inquiry and personal selection, and given preferably in the homes of the recipients, to the very young, the aged, and the infirm, who are in need of support, and to whom the labour-test is obviously inapplicable. These principles seem simple enough, but when they are practically applied to the millions constituting the population of an Indian province, they represent a task of immense difficulty and responsibility. And within these broad and permanent lines of strategy, tactical dispositions have to be made to meet each local phase of distress, while the duty of discerning the character and degree of the distress as it revealed itself in each locality calls for the most delicate observation and the finest judgment. No drill-book can win a campaign, and no famine code of itself can successfully combat a famine. Several circumstances contributed on this occasion to enhance the difficulty of the problem. Where, as in the Central Provinces and Berar, the people had become familiarised with the relief system of the famine code, they showed an embarrassing readiness to avail themselves of it the instant relief was started. This inclination was further stimulated by the enhancement of the famine relief wage in accordance with the recommendation of the Famine Commission of 1898. I do not blame the people for the very practical way in which they signified their approbation of the relief system, but it had the serious inconvenience of overtaxing the staff at the disposal of the local administrations, and of preventing the orderly enforcement of the labour test, which must be the basis of all well-considered relief for the able-bodied. In Guzerat and Khandesh on the other hand, especially in the broken country descending from the table-lands of Central India and the Deccan—a forest land sparsely inhabited by aboriginal jungle tribes—the difficulty was to familiarise the people with the relief system, and to induce them to comply with its requirements. They had never before experienced such a drought, and life on a relief work was strange and distasteful to them. They clung to their homes and their famished cattle after the means of support had failed them; and when at length they came on the relief works they were unable or unwilling to work. In all provinces in the first stage of the famine there was an insufficient supply of suitable projects for the employment of famine labour, a deficiency of officers and subordinates, and a deficiency of tools for the relief workers. In the Central Provinces, the Punjab, and Berar, the programmes of famine-relief works had been well-nigh exhausted in the 1897 famine; while in Guzerat they had not been fully maintained owing to the belief that that province enjoyed immunity from drought. The difficulty of insufficient establishments was more or less felt throughout the whole period of the famine, and it will easily be understood that the ordinary civil administrative staff of an Indian province is not designed to superintend famine-relief on the enormous scale which it assumed on this occasion.

The relief problem in the native States was still more intricate and perplexing. There were a few strong States of which the Gwalior State in Central India was a conspicuous example, which had ample cash resources and sufficient administrative machinery for meeting the emergency without extraneous help or guidance. There were others which had money, but which required guidance and assistance. But the majority had neither the ready money nor the machinery for relieving their people. This by no means implied financial or administrative mismanagement. It was simply that the revenues of the chiefs, derived wholly as it is from the land, suddenly failed them, and that their loose tribal or semi-feudal organisation was unequal to the strain of a great famine.

In a special degree this was the case with the ancient States of Rajputana, whose loyalty and attachment to the Crown make their preservation and well-being a matter of special concern to the Indian Government. Famine has been quaintly termed by an old writer, "the grand natural disease of Rajputana." Many grievous droughts have fallen upon it, which the common folk have met by emigration, and the chiefs by presents to the Brahmins and by gifts of gold and silver in the temples of the great gods. But on this occasion emigration was a hopeless expedient, while higher ideals of duty had insensibly made their way into the political system. At the outset the rulers and their subjects were paralysed at the calamity which had befallen them, and no doubt more might have been done, in August and September, to prevent the wandering and fruitless migration which proved so destructive to men and animals. But under the encouragement of the political officers and with the financial assistance which the Government of India freely offered, the courage of the chiefs revived, and they manfully entered upon measures for the relief of their people. The general line of policy adopted by the Government of India was to proffer loans of money and expert advice, but to refrain from direct interference with the States in their management of relief, and from anything which might impair the natural responsibilty of the Chiefs. The results of this policy have greatly exceeded expectation. There were no doubt occasional failures and mistakes. But in most States a very material amount of relief was given to the people, while in several, the standard of efficiency, though not of expenditure, was not far short of that in force in British districts.

In estimating this efficiency we have, I should mention, to take account of two special features in the social and political system of States organised as the States of Rajputana. The first feature is that the social order as a whole, permeated as it still is by ancient tribal ideas, hangs together much more solidly than it does now-a-days in British India. The poor are still the retainers, or the prædial serfs, of the wealthier classes, and as such are helped along in times of distress. In British India the landholder or the substantial farmer at once turns off his farm hands, and expects the Government to feed them. The second feature is that the chief is very much in the position of our Norman kings. There are the crown lands, and there are the fiefs of the great vassals, which bring in little to the overlord, save empty homage. The Rajput chief will ordinarily recognise his duties to the people of the Crown or *Khalsa* lands, and will be prepared to relieve them according to his resources, but his instincts rebel at the idea of extending similar treatment to the dwellers on the lands of the feudatories or *jagirdars*. He expects the latter to provide for their own folk. There is a great deal to be said for the chief's point of view, but it was open to the practical drawback of excluding large sections of the population from relief, owing to the great difficulty experienced in enforcing the obligations which he held to be due from the jagirdars. I might enlarge further on other features of a Rajput State necessarily result, ing in a standard of relief which would be judged inadequate in British India; but the two I have described sufficiently illustrate my point.

The next group of States which occupied the attention of the Government of India, were those forming the Central India Agency. Here the drought was less continuous and less intense than in Rajputana, while the States themselves presented much greater variety of conditions. The one extreme was represented by the large and enlightened Mahratta State of Gwalior, and the other by the congeries of petty Rajput chiefships known as Baghelkhand. The same policy of encouragement and, where necessary, of financial assistance was followed by the Government of India, but the emergency, as a rule, was not so great as in Rajputana.

Next come the powerful and wealthy States of Baroda and Hyderabad, which were quite capable of managing their own famine relief, and required little advice or assistance. The number of emigrants from these States into Guzerat and Berar was the subject of some discussion, and pointed to insufficient relief measures in the early months of the famine. That this was the case may perhaps be thought to receive some corroboration from the very considerable decrease in the population of these States, which the recent census has revealed.

There are left for mention the native States in political relations with the Punjab and Bombay Government and the feudatory States attached to the Central Provinces. The principal Punjab States affected were Patiala, Jind, and Nabha, but except in Patiala, where relief was unduly delayed, measures were promptly and efficiently taken by the ruling chiefs. In the Central Provinces relief on a moderate scale was also given in most of the feudatory States with satisfactory results. In the Bombay Presidency the relief problem in native territory was a very serious addition to the anxieties of that Government in respect to its own districts. The populous and fertile States of Kathiawar were involved in the same disaster as Guzerat, as was also the well-devoloped State of Palanpur and the broken and hilly territory forming the Rewa Kantha and Mahi Kanta agencies. Distress was also severe and general in the Deccan and South Mahratta States. In fine the affected area and population in the Bombay States did not fall far short of the affected area and population in the British districts of the Presidency, while the task of organizing an efficient system of relief within their financial and administrative capacity was one of exceeding difficulty. Nearly every State stood in need of ready money. Their investments in railways and in Government paper could be realised only at a ruinous loss; there was very little loanable capital in the country, and there were manifest objections to the States borrowing in England. In most cases the Government of India found it necessary to make loans to the States on easy terms, and with this financial aid and with the expert assistance of British officers a very considerable amount of relief was afforded to the people.

Such in brief outline were the conditions of the relief problem which the Government of India and the subordinate provincial Governments had to face in the autumn of 1899. I have endeavoured to show that in British India the situation presented some exceptional difficulties, and that in native States it was grave and complicated in the last degree. No view of the late famine is just, which omits to recognise the weight and magnitude of the responsibility which the Indian Government accepted in acting as the friend, the adviser, and the banker of a bewildering multitude of native States, each one differing from its neighbours in resources, requirements and capacity, and each needing to be separately studied and separately treated. It speaks well of the relations subsisting between the paramount Government and the ruling chiefs, that the latter, at no small personal sacrifice, have so willingly and generously accepted the principles of famine relief, and have so honestly endeavoured to give effect to them.

IV. The Chief Features of the Relief Campaign.

A connected narrative of the relief campaign, which opened when the drought had unmistakeably declared itself in October, 1899, would far exceed the limits of this paper. I propose merely to indicate its principal phases, and to draw attention to the points of primary interest and importance. We may conveniently divide the history of the relief operations into four periods. The first starts from the commencement of relief, in the autumn of 1899, and runs to the end of February or the beginning of March in the following year, by which date the cold weather season was virtually over. The second period embraces the hot weather months, when drought was at its height. The third period covers the two anxious months of July and August, during which time the weak and doubtful character of the monsoon led to a very serious protraction of relief. The final period, so far as this review of the famine is concerned, commenced with the fortunate re-establishment of the rains and witnessed the gradual contraction of relief and the return of the people throughout the greater part of the famine area to their ordinary occupations. In the ill-starred Bombay Presidency relief operations continued after the close of 1900, and the numbers on relief again rose rapidly in the hot weather of 1901, and after sinking with equal rapidity during the early months of the rains have again risen on account of the deficient rainfall in Western India, and threaten to rise continuously till the next monsoon sets in. But with the exception of Bombay and the adjacent native States the famine of 1899-1900 may be regarded as ended by December, 1900, having lasted for 15 months, while the actual crisis was passed by the end of August.

Each of the four periods with which I have divided the famine had its peculiar features, and is marked by special incidents. The first period—from October, 1899, to March, 1900—was the preliminary period of expectancy, of anxious forebodings deepening into certitude as to the magnitude of the calamity, of rapid marshalling of the forces of relief, and of unrest and despair on the part of the people. In many native States, certainly in most of the Rajputana States, and probably in Hyderabad and Baroda, relief was undoubtedly behindhand, and much ground was lost which could not be recovered. In British territory, especially in the Central Provinces and Berar, such ample facilities for obtaining relief were given to the people, and were so readily accepted, that its due regulation became a matter of urgency. Thus the two special features of the first period, as regards British India, were the excessive number of persons on relief as compared with any previous famine, and the efforts made by the Government to prevent relief from degenerating into a disorderly profusion. The enforcement of the labour test, the limitation of the worker's pay to a subsistence wage, and the exclusion of able-bodied persons from gratuitous relief, were the three cardinal points which engaged attention, and on which discussion centred. The evidence seems to me conclusive that the action which was taken in the several provinces on the initiative of the Government of India to make the conditions of relief stricter was absolutely necessary. I do not say that mistakes may not have occasionally been made in particular places in carrying out this policy, but as to the necessity for and the reasonableness of this policy I entertain no doubt. In the final report on the famine in the Central Provinces the Chief Commissioner recounts that "at the commencement of relief operations the general tendency of officers was to over-indulgence," and he explains how it took some time before they realised that "the attitude of the people had changed from the over-reluctance of the last famine to the over-readiness of the present time." He mentions how he had satisfied himself in his local inspections in the first months of the famine that, as a rule, the workers were under-tasked. He found, for instance, that in some cases the workers did not put in an appearance until 10 o'clock in the morning, and that in others the tasks were finished by 2 o'clock in the afternoon. What was the case in the Central Provinces was the case in other provinces where the people were familiar with the rules of famine relief, and had not efforts been made to tighten up the relief system, and especially the conditions of employment on relief works, a very grave scandal would have ensued.

The case was somewhat different in Guzerat and Khandesh, where famine was a novel experience. In open populous tracts, of which the small district of Broach is a typical instance, relief works "caught on" at once with the low caste labouring population, and proper enforcement of the labour test became imperative. But in the broken uplands of the Panch Mahals and Western Khandesh, inhabited by Bhils and other jungle tribes, and in the great grazing plains of Guzerat, the home of herdsmen and shepherds, the ordinary relief system failed to afford sufficient relief. To shy forest folk or to pastoral races life on a large relief work was abhorrent. They needed to be sought out and provided with special employment or else gratuitously relieved. Unfortunately this was not recognised at first, and practically what happened was that the ordinary relief works which were opened in the Panch Mahals and other similar localities in Guzerat and Western Khandesh failed to fill, and no sufficient measures were taken to meet the distress until it had made very considerable headway. In the Panch Mahals, a district with about 300,000 inhabitants, there were only 16,000 persons on relief works and 21 persons on village gratuitous relief at the end of January, 1900. Contrast this with Betul, a district in the Central Provinces, also with a population of 300,000, and similarly inhabited by jungle tribes. In Betul, at the same date, there were 110,000 persons, or one-third of the population, on relief, of whom 10,000 were fed in kitchens, 17,000 were recipients of cash or grain doles in their homes, while 83,000 were found congenial employment in the forests. If, as is probable, there was an excess of relief in Betul, it is certain that in the Panch Mahals relief was insufficient, because it was unsuitable.

I pass now to the second period of my narrative—the period from the beginning of March to the middle of June, when the monsoon is due in Western India. It is impossible to bring home to persons whose experience is confined to temperate climes the pitiless aspect of nature at the climax of a great drought, or the demands it makes on the physical powers of man and beast. "The sky is of brass and the earth of iron," writes one much-tried famine officer. Another, describing his work in a central State of Rajputana, writes: "The country for months past was parched like a cinder. Every blade of grass had long perished. Many trees had died, and those that lived had but a few loose lifeless leaves. The earth was like a desert, and the spirit of desolation brooded over everything." Suffice to say that this second period was marked by extreme drought and heat, by virulent epidemics of cholera in the relief camps, scattering the inmates and causing great mortality and suffering, by the continuous increase of the numbers on relief, by the alarming rise of the death-rate in Guzerat, and by many other unmistakeable signs of extreme distress in the northern districts of Bombay, and in Baroda, Central India, and Rajputana. In the Central Provinces and Berar the general health of the population, except for cholera, continued remarkably good, and there was no reason to doubt the adequacy of the relief afforded. But it was on a scale of unprecedented magnitude. In May there were close on 2,000,000 persons on relief in the Central Provinces, or nearly 20 per cent. of the population. In Raipur, the largest district of the province, the proportion reached 40 per cent., and exceeded 30 per cent. in several other districts. In the adjoining province of Berar 30 per cent. of the population of one district, and 25 per cent. in another were in receipt of relief. But there was this important distinction between the two provinces, that whereas in the Central Provinces one person in every four receiving relief was relieved gratuitously at his home, in Berar home relief was restricted to one person in every twelve. The activity of private charity in Berar may partially explain this distinction. But when we further find the practice in the Punjab in this matter conforming with that of Berar, and when we note that in both these provinces relief operations were admittedly adequate, we can scarcely fail to see in the figures for the Central Provinces an illustration of the general tendency towards indulgence to which the Chief Commissioner in his retrospect of the famine has referred.

In the Bombay Presidency relief remained on a smaller scale, though considerable if compared with hitherto accepted standards. At the end of April, for instance, there were 400,000 people on relief in the two Deccan districts of Sholapur and Ahmadnagar, representing 25 per cent. of their united population. In Ahmadabad, Kaira and Broach, the three central districts of Guzerat, about 18 per cent. of the population was on relief. Even in the Panch Mahals, the numbers had risen to over 50,000. In the open populous tracts sufficient relief-works had been opened for all the able-bodied section of the population, and gratuitous village relief had been considerably extended, although in comparison with what was permitted in the Central Provinces, it was still on a very exiguous scale. But the towns were thronged with starving wanderers, and it was becoming clear that for some cause or other relief had failed to reach the poor and ignorant classes at the bottom of the social scale. The relief problem in Guzerat was indeed most perplexing and heart-breaking, and baffled even the most experienced officers, who had never imagined that so rich and prosperous a country would succumb so rapidly and completely to a single year of drought. Had this been anticipated before the event, relief no doubt might have been made more effective, though a high mortality was inevitable on account of the deadly and disturbing assaults of cholera and the influx of moribund wanderers from native territory.

The third period of the famine extended from the middle of June, at which date the monsoon rains ordinarily set in, to the beginning of August. For in 1900 the monsoon was not satisfactorily established till the end of July, and during this anxious period of suspense, the crisis was unfortunately protracted, and the people were unable to return with confidence to agriculture. It was not till August that there was reasonable hope that the crops would survive. The third period consequently was marked by the continuance of relief on an undiminished scale, at least, in British India, but with important changes in its form to adapt it to the changed season of the year. Relief by means of works contracted, and gratuitous relief by means of village kitchens and village doles expanded. This was especially the case in the Central Provinces, where, in anticipation of the rains, a novel policy had been elaborated. That policy in brief was to close most of the relief-works on the advent of the rains, sending the workers to their homes with the guarantee that they would be relieved there, in the case of the able-bodied by employment under the village headmen, and in the case of others by free kitchens. Free kitchens thus became the main feature of the relief system in the Central Provinces from June onwards. They were open to all comers, and they were multiplied at the discretion of the famine officers, and became exceedingly popular with the people. At the end of July there were still over 2,000,000 persons on relief in the Central Provinces, of whom 1,400,000 were fed in kitchens. In several districts between 20 and 30 per cent. of the population daily attended these institutions. It is claimed for the kitchens that they prevented great mortality, and successfully carried the people through a very trying time. But there can be little doubt that they were largely abused, and that they led to idleness and loafing when field work had again become abundant and farmers were clamouring for labourers. The Famine Commission have severely condemned them, and it is safe to predict that this kind of relief will never again be extended to the able-bodied.

In Bombay there was also during the third period a considerable expansion of gratuitous relief in the villages, the number of persons thus relieved rising from 140,000 at the end of May to 400,000 at the beginning of July, and to 522,000 at the end of August. The persistent rise in the death-rates of the Guzerat districts from January to June, and the many evidences that large sections of the population were not being reached by relief-works, made this inevitable, and fully condoned the abandonment of the restrictions on gratuitous relief which had been observed in Bombay in the earlier periods of the famine. I feel that I do but echo the feelings of the majority of officers who served in Guzerat in expressing the opinion that that gratuitous relief in the villages was unduly restricted in the province in the earlier stages of the famine, and that much genuine distress might have been averted had it then been more freely given.

In the Punjab and Berar it was found possible to carry the people through this trying third period without extraordinary expansion of the gratuitous relief system, and to get them from the works back to their fields without excessive difficulty as soon as the season permitted cultivation to be resumed. This process was, as elsewhere, delayed by the late setting in and the uncertain character of the monsoon. But in both these provinces the authorities appear to have had the relief system well in hand, and to have adapted it prudently to the necessities of the situation.

The fourth stage of the famine may be briefly dismissed. At the end of August, prospects were sufficiently assured, except in the Bombay Presidency, to bring the end of relief within sight. There were still over 4,000,000 of persons on relief in British India, of whom more than half were in the Central Provinces; and 1,150,000 in native territory. But at the end of September, these numbers had fallen to 2,660,000 in British India, and 500,000 in native States. At the end of October, the British India figure had further fallen to 1,250,000, and the figure for native States to 176,000. At the end of December, 1900, relief was confined to the Bombay Presidency.

To illustrate my narrative, I have prepared two Tables, showing respectively the number of persons on relief in each province at different dates, and the percentages of the population on relief. The Tables bring out the high figures which relief maintained throughout in the Central Provinces, and also the extent to which the labour-test was dispensed with. They also show the comparatively moderate character of the relief given in the Punjab and Berar, and the smallness of gratuitous relief in Bombay during the early months of the famine. The figures for native States illustrate the relative frugality which characterised their relief operations, and the comparison between the relief percentages maintaining in them and in British provinces respectively may perhaps be found instructive and interesting.

The direct expenditure on the famine in British India amounted, up to the 31st March, 1901, to £6,300,000. Agricultural loans and advances amounted to £1,200,000. Loss of revenue and indirect expenditure is estimated at £2,700,000, after taking credit for £700,000 accruing to the Government as additional receipts from railways and canals. The aggregate cost is thus not far short of £10,000,000 sterling.

The direct and indirect expenditure, incurred by native States on account of the famine is necessarily a matter of uncertainty. £3,000,000 in the two years ending the 31st of March, 1901, was lent to them by the Indian Government for famine purposes, and this does not represent by any means the whole of their indebtedness. The famine expenditure and revenue losses of the Rajputana States are believed to exceed £1,000,000, towards which the Indian Government lent £400,000. From such information as I have been able to obtain as to the expenditure and loss of other States, I am inclined to place the total expenditure and revenue losses, of all States affected by the drought, at between £4,000,000 and £5,000,000.

On the question of the mortality occasioned by the famine I must, as regards British India, rely on the very thorough and careful inquiry contained in the report of the Famine Commission. Their conclusion is that the excess deaths in British India due to the famine were about 1¼ millions, and they conjecture that of these excess deaths 1,000,000 occurred among British subjects, and the balance among immigrants from native States. They also consider that of the total excess mortality, at least one-fifth was due to cholera. These figures are lamentably high, but it must be clearly understood that they by no means indicate that this number of deaths were directly occasioned by starvation or privation. There cannot be intense and prolonged drought without much exceptional mortality due to other causes than want of food. The Central Provinces are a signal instance of this. Such was the liberality of the relief dispensed, that a starving person, with the possible exception of an occasional immigrant from outside, was unknown there throughout the famine. Yet the excess mortality from fevers and other diseases, especially in the rainy season of 1900, was very considerable.

As to the mortality in native States, our only guide is a comparison between the population statistics of the recent census and those of the census of 1891. Taking the native States affected by the famine they had in 1901 a population of 42,000,000, and they have now a population of 36,000,000 only. The decline in the decade is 14½ per cent. In the States which were not visited by the famine the population has increased by over 12 per cent. That the famine of 1900 is the chief cause of these very different results can hardly be doubted, but it would be unsafe to found on them any close calculation as to the actual excess mortality due to famine.

The question naturally arises, are the effects

TABLE I.—NUMBER OF PERSONS ON RELIEF.

	End of November, 1899.			End of February, 1900.			End of July, 1900.			End of September, 1900.			End of November, 1900.		
	On works.	Gratuitously relieved.	Total.	On works.	Gratuitously relieved.	Total.	On works.	Gratuitously relieved.	Total.	On works.	Gratuitously relieved.	Total.	On works.	Gratuitously relieved.	Total.
Bombay	202,000	6,000	208,000	1,030,000	72,000	1,102,000	1,136,000	407,000	1,543,000	485,000	495,000	980,000	136,000	125,000	261,000
Punjab...	73,500	1,500	75,000	182,000	25,000	207,000	136,000	40,000	176,000	3,000	27,000	30,000	—	—	—
Central Provinces	385,000	225,000	610,000	1,112,000	306,000	1,418,100	531,000	1,624,000	2,155,000	125,000	1,320,000	1,445,000	—	76,000	76,000
Berar	52,500	500	53,000	268,000	40,000	308,000	346,000	147,000	493,000	70,000	122,000	192,000	6,000	23,000	29,000
Other provinces	79,000	9,000	88,000	92,000	20,000	112,000	97,000	45,000	142,000	13,000	19,000	32,000	—	—	—
Total British India...	792,000	242,000	1,034,000	2,684,000	463,000	3,147,000	2,246,000	2,263,000	4,509,000	696,000	1,983,000	2,679,000	142,000	224,000	366,000
Native States	366,000	36,000	402,000	954,000	154,000	1,108,000	1,285,000	456,000	1,741,000	246,000	238,000	484,000	34,000	26,000	60,000
Total British India and Native States.	1,158,000	278,000	1,447,000	3,638,000	617,000	4,255,000	3,531,000	2,719,000	6,250,000	942,000	2,221,000	3,163,000	176,000	250,000	4.6,000

NOTE.—Persons relieved gratuitously at the relief works, as dependents of the relief workers, have been included in the numbers shown as "on works."

TABLE II.—Percentage of Population on Relief in Each Province.

	Affected Area and Population.		End of Nov., 1899.	End of Feb., 1900.	End of July, 1900.	End of Sept., 1900.	End of Nov., 1900.
	Square Miles.	Population.					
British Provinces:							
Bombay	50,000	8,000,000	2·5	13·8	19·2	12·2	3·3
Punjab	14,000	3,000,000	2·5	6·9	5·8	1·0	..
Central Provinces	70,000	8,500,000	7·2	16·7	25·3	17·0	0·9
Berar	16,000	2,500,000	2·1	12·3	19·7	7·2	1·1
Total	150,000	22,000,000	...	...	...	...	...
Native States:							
Rajputana	90,000	8,500,000	1·1	4·4	5·0	0·9	0·1
Central India	30,000	3,500,000	0·6	3·9	3·9	1·2	0·1
Hyderabad	50,000	7,500,000	...	1·5	6·1	2·2	0·1
Baroda	7,000	2,000,000	...	3·1	5·1	2·4	0·8
Bombay Native States	40,000	5,500,000	5·3	7·2	8·6	1·9	0·5
Punjab Native States	10,000	1,000,000	...	0·3	4·4	1·2	0·1
Central Provinces Native States	15,000	1,000,000	...	1·8	5·7	2·7	...
Total	242,000	29,000,000	...	...	...	...	...

of the famine likely to be lasting. Does the country show signs of recovering from it? In answering it I would distinguish, in the first place, between tracts where the cattle losses have been great, and tracts where they have not been serious; and, in the second place, between tracts where the rainfall in 1900 and 1901 has been good, and tracts which have again experienced a short monsoon. Applying these considerations I may say that Berar exhibits the most complete recovery, since its cattle losses were inconsiderable, and the seasons have been good. Judged by the usual statistical tests of cultivation and production Berar now exhibits no external marks of the famine. The same might, I believe, have been said about the greater part of the Central Provinces, were it not that last year's monsoon and the present year's winter rainfall have been seriously deficient. In the Bombay Deccan and Guzerat, in Ajmer and in the South-East Punjab, there has not been a single good season since the famine of 1899. Moreover, the losses of cattle have been on an enormous scale. These tracts have had no chance of recovery. Descriptions which I have lately seen of the existing desolation of Guzerat recall the early months of 1900, and the continuance of relief on a very large scale till next July or August next is certain.

As to native States Baroda is in the same condition as Guzerat, and so are considerable tracts in Rajputana and Central India. Hyderabad, on the other hand, is in a fair way towards recovery. Rajputana will take many years to recover its flocks and herds and its population. Many of the ruling chiefs are heavily indebted to the Indian Government, and their revenues are seriously reduced. The same is the case in the native States of Kathiawar and Guzerat.

I may here express an opinion that the experiences of the late famine should suggest to native States the expediency of maintaining a financial reserve to meet the drain of similar future calamities. There are very few States in India so fortunately situated as to be entirely immune from drought. The security which the Kathiawar States were reputed to enjoy has proved as misleading as that of Guzerat. I have explained the embarrassments into which most of the States were plunged when they were suddenly confronted with the drought of 1899, and had to undertake the task of relieving their subjects with an empty treasury and unrealisable investments. In local droughts, the traditional expedient of expecting the population to shift for itself by migration, may still suffice in Rajputana, and I do not decry it. But migration is worse than useless in a great famine and, in that case, the responsibility of the ruling chief cannot be shifted. Not that I think that the native chiefs would desire to evade an obligation, which is so clearly enforced by economic as well as by ethical considerations. But to discharge it, they require a "famine chest," into which the savings of good years should be placed.

V. THE REPORT OF THE FAMINE COMMISSION.

In this brief and imperfect sketch of the famine relief campaign of 1899-1900 I am conscious that I have omitted many topics of importance and interest. I have said little or nothing as to the rival merits of large and of small relief works, or as to the way in which a famine intelligence staff is organised, or as to the most hopeful expedients for saving the agriculturists' cattle, or as to the famous battle of the famine-wage, or the equally famous battle over task-work and piece-work. My space being limited, I have thought it best to confine attention to the broad features of the struggle, and to lay stress on the contrast between the relief standard in native States and in British India, and on the equally striking differences between the strict orthodoxy of the Bombay relief system, pursued in the face of novel and unfavourable conditions, and the indulgent innovations devised in the Central Provinces in the desire to avoid the smallest risk. But I venture to hope that even my superficial narrative will have shown that the famine and its management raised large questions of policy which required to be critically examined by the strongest Commission which the Government of India could appoint. The Commission, as you know, reviewed the administration of famine relief in the several provinces, and have commented with great ability and weight on the leading incidents of each provincial campaign, and have exhibited and illustrated the effects of the particular measures taken, and the particular principles and methods of relief adopted. Their general conclusion is that "in the main, and taking the famine period as a whole, the relief distributed was excessive;" and they attribute the excess to "an imperfect enforcement of tests on relief works, a too ready admission to gratuitous relief, and a greater readiness on the people's part to accept relief owing to the demoralising influences of the preceding famine." They are far from advocating a departure from the humane policy of famine relief which the Indian Government has accepted. But they consider "that the object in view can be attained at a moderate cost and little demoralisation, if prudence and foresight be duly exercised, and if means be properly adjusted to ends." In this spirit they re-state the principles by which alone, in their opinion, famine relief on a great scale can be successfully administered, and they make many important recommendations for future guidance. These recommendations are for the most part under the consideration of the provincial Governments, and I do not propose to discuss them. Nor do I propose to examine the judgments or findings which they have recorded on the management of the famine in the several provinces. But it may avoid a possible misunderstanding of the attitude of the Commission if I point out that their concern is not with the past, but with the future. Their findings are, therefore, not of the nature of censures, but of advice and warnings. And though these findings may not be universally accepted, they are on the whole, I venture to think, borne out by the evidence, and based on correct principles. There cannot be a perfect science or art of famine relief. The famine administrator is between the Scylla of insufficient relief and the Charybdis of excessive profusion. Errors of tactics and of judgment will continue to be made, and circumstances will arise which cannot be met by the accepted rules. But after allowing for this, I feel convinced that the Report of the Commission will prove to mark a great and permanent advance in famine administration.

VI. FAMINE PREVENTION.

In the last part of their Report the Famine Commission discuss the question of protective measures, and make a series of recommendations of the highest interest and importance. I will merely enumerate them. Dealing first with the collection of the land revenue, they recommend that the procedure should be more carefully adjusted to the vicissitudes of the season. They next urge the value of agricultural banks and other forms of co-operative credit, so as to provide the cultivators a means of obtaining, at moderate rates of interest, advances for carrying on their business; and they also make recommendations for improving the system of Government agricultural loans and advances. They then turn to the special question of agricultural indebtedness in the Bombay Presidency, and recommend legislation which will enable the ryots to compound with their creditors, and which will restrict the transferability of land. Lastly, they touch on the possibilities of agricultural improvement, especially in the matter of irrigation; and they express their opinion that there is still a wide field for the construction of irrigation works. "All provinces," they say, "do not, indeed, present practicable schemes for the construction of great canals, but the possibilities of smaller protective works have in no province been exhausted, while in some provinces they have, as yet, hardly been examined. For storage tanks, reservoirs, and, above all, irrigation wells, the scope and the necessity are very great.''

This is a great and worthy programme, and I feel certain that it is receiving, and will continue to receive, the most sympathetic attention of the Indian Governments, and that no considerations of trouble and expense will deter them from giving effect to it so far as it may be found to be practicable. For there is always an ideal element in such large programmes which tends to make the actual realisation disappointing in its results. I have followed carefully the evidence, so far as it is reported in the Indian newspapers, which has been taken by the Irrigation Commission now at work in India. I think it confirms, on the whole, the view of the Famine Commission that the possibilities of small protective works have not been exhausted. But it also indicates that these possibilities may be more restricted in their protective value than is sometimes supposed. Storage tanks and reservoirs and non-perennial canals are excellent in their way in seasons of slightly defective rainfall. But the protection which they give in a year of intense drought is often very small. Take the case of Ajmer. The whole country is a mass of tanks and storage reservoirs, but in 1899 they were dry. Then, again, in the Deccan, and in the corresponding tracts in the Central Provinces and Central India, the physical properties of the predominant soil make irrigation excessively difficult. Mr. Mollison, the present head of the Agricultural Department in India, who is thoroughly conversant with the Deccan country, gave very remarkable, and by no means optimistic, evidence on this point to the Commission. I am afraid that over large tracts of India, which cannot be reached by perennial canals, agriculture will always remain precarious and liable to heavy losses in years of drought. It is this fact that makes the commercial and manufacturing development of India, the fuller utilisation of its mineral resources, and the more varied employment of its cheap and abundant labour, so pressing and so important. I venture to think that there are great possibilities in this direction, and that in their eventual realisation we shall find the ultimate solution of the drought problem—that skeleton in the closet of every Viceroy and every Indian Minister of Finance.

DISCUSSION.

The CHAIRMAN said:—I wish to preface the remarks I have to make to you by congratulating Mr. Holderness, and I do very warmly congratulate him upon the paper with which he has favoured us. It is, I think, a paper of exceptional interest and ability. As Mr. Holderness has said, the subject is so large, and the questions involved so numerous and intricate, that it was a matter of no small difficulty to treat them within the limits of a paper to be read before this Society. But I believe you will agree with me in thinking that Mr. Holderness has overcome the difficulty in a remarkable manner, and has presented us with a sketch of the causes, working, and consequences of the last famine which, for lucidity and comprehensiveness, leaves little to be desired. I agree so largely on most points with the views expressed by Mr. Holderness that I almost owe you an apology for at all trespassing on your attention; but there are some matters on which I should like, with your permission, to say a few words, more by way of supplementing the paper than by way of criticism on it. Mr. Holderness began by saying that a famine in India no longer denotes an absolute dearth of food. I would ask you to consider for a moment what that statement signifies, for it really denotes one of the most remarkable achievements of recent Indian administration. It is not so long since famine in India meant the final horror of actual want of food. It meant it in the Orissa famine of 1866; it meant it even more acutely in the Madras famine of 1877. But in the last two great famines—that of 1897 and that of 1900—there was never any want of food in the famine-stricken districts; there was only a want of money wherewith to buy food. This transformation in the famine problem, this great reduction in its difficulties, is due, Mr. Holderness tell us, to improved communication and to irrigation, and no doubt that is so. But, without wishing in any way to depreciate the importance of irrigation as a factor in the question, I believe that looking to the past the share in the great and beneficent result due to railway extension during the last 20 years is greater than the share due to irrigation. There never has been in the past, and, judging by the past, there never will be in the future, a failure of the crops throughout the entire Indian continent. In the worst famine years of which there is a record there have been vast regions larger than European kingdoms which remained unaffected by drought, as they were unprotected by irrigation. The surplus stocks from such regions, which, compared with the surplus stocks of canal irrigated tracts, are enormous, could not on an emergency in former times be moved to distant parts stricken by famine; but now they can be easily and quickly transferred by our system of protective railways. These railways have, therefore, completely transformed the aspect of the famine problem, and reduced it from an often insoluble one of how to procure food to the comparatively simple one of how to distribute the price of food without demoralising its recipients. I think I am justified in claiming that transformation as a signal example of British administrative foresight and skill. But, in these days, we are nothing if not sceptical; and people are found to say that instead of alleviating, railways aggravate the ills of the Indian peasant. These critics maintain that, by affording the cultivator a ready and tempting market for his produce, railways destroy the habit of storing grain, which was, it is alleged, a safeguard against famine in former years. Well, all I can say is that these critics have short memories. They forget that in the pre-railway days individual grain stores always proved a broken reed in the fight with famine. They forget that where railway communication has been effectively established there no dearth of food has been ever felt. In truth, the beneficial effect of railways as an instrument of famine relief is indisputable, and their utility in the long run in improving the condition of a country, seems to me to be equally free from doubt. It surely stands to common sense that the individual and the country must be benefited by the opportunity of getting higher prices for their produce. Looking at the general condition of India, I would say that the country's greatest need is the need of being wakened up—wakened up from the apathy of ages, and started on a career of social and industrial progress. But without stimulus from outside, the native of India will not move. Unlike the Western, with his restless striving after material prosperity, the Oriental aims at rest of mind, and he is content to keep the place into which he was born. But under the modern dispensation, we must advance or we retrograde. Unfortunately, the influences which most powerfully affect the Indian—the religious obligation to raise a family, the legal obligation to distribute his property, the caste prohibition to enter on derogatory avocations—all these make for retrogression. Education is the great remedy; and there is in India no greater educator than the railway. If, then, the famine problem has been so much simplified by railways, do we not exaggerate the remaining difficulties in the way of effective famine relief? Ought not the distribution of money among the indigent—to which at bottom the famine problem is now reduced—to be a comparatively simple business? In truth, it is very far from being a simple business, it is an exceedingly complex business; and the reason of its complexity is, that no relief administration can be pronounced successful which, in addition to keeping the people alive, does not also preserve their industrious habits, and save them from the demoralisation which public charity brings in its train. Some degree of demoralisation under the conditions of famine relief, is, I am afraid, inevitable and independent of time and place. It was found to be so in France in Turgot's time. It has been so in every Indian famine; but it is, I am convinced, reducible to small dimensions in India by a happy combination of means and a dexterous adjustment of relief methods to the circumstances of time and place, and to the customs, feelings—perhaps I should even say to the prejudices, of the people. But in these adjustments, great, often almost heart-breaking, difficulties are experienced. When these are encountered, under the blazing sky of an Indian summer, amidst recurring scenes of pestilence and death, with no amenity of life to relax the constant strain of duty, then the wonder is that such a measure of success has been attained as the annals of recent Indian famine campaigns present. For a successful famine campaign, two things are essential—prevision and pre-arrangement. Prevision depends on the effective organisation and maintenance, in ordinary years, of a strong Intelligence Department. Pre-arrangement postulates the holding in readiness, as a matter of every-day precaution, of an adequate programme of relief operations with a sufficient staff *cadre* and equipment. In famine, as in war, you may not safely improvise. Our arrangements may be such that—

> " —at the haggard trumpets, instant your soul shall leap,
> Forth-right, full-harnessed, accepting—alert from the wells
> of sleep."

With an Indian Government forewarned and forearmed in this way, the fight with famine, becomes as Mr. Holderness has said, a matter of tactics, and the greatest victory will lie with that Government which is most resourceful and makes most use of non-official, especially native, agency. The true tactical principle was enumerated by Turgot 130 years ago—"The best relief system is that which enables people to help themselves." From that precept it follows that labour should be the foundation of relief, and economy its keystone. It is only by making able-bodied people work for their living that industrious habits, self-respect, and discipline can be preserved among famine-stricken people. I attribute the marked absence of demoralisation during the famine of 1897 and afterwards, in the North-West Provinces and Oudh, to the strict enforcement of the labour test; and in my opinion—shared, as I understand, by Mr. Holderness—the huge numbers on relief in 1900 were in great measure due to the demoralisation which followed an imperfect enforcement of the test, and a profuse distribution of gratuitous relief. At the risk of repetition, I again insist on the vital importance of economy in relief administration. I insist upon it, not so much in the taxpayers' interest—that, with me, is an entirely subordinate consideration in this connection; but in the interests of the distressed people themselves. Being quite convinced that proper economy is fully compatible with the policy of preventing famine mortality, and being satisfied that numberless evils follow from the disorganisation of industry and the demoralisation of life, which profusion in relief causes, I have come to regard economy in famine relief admistration as almost on a par in importance with the saving of human life itself. In regard to native States, I agree with Mr. Holderness in thinking that most States endeavoured, in 1900, to bring their relief measures into line with the humane practice of the British Government, but I confess that I feel anxiety as to the ability of most States to maintain such a policy in perpetuity, and as to the effect upon their temper and feelings of expenditure framed on the British model. Few native States are rich; few have developed credit. New ideas make way slowly in them; and expenditure in famine relief necessitates the curtailment of expenditure in directions which immemorial custom in those States has hallowed. I hesitate to say that our relief policy is popular with all native States. I am sure they think our scale of relief rations to be quite extravagant; which, by the way, affords a curious comment on the complaints of our own native politicians that our scales of rations are too low. The relief problem in native States is a difficult and delicate one, and calls for the most tactful and considerate treatment. I can only hope that a long cycle of good years will now ensue, during which prosperous harvests will enable the native States to recoup the losses of the past few years, and lay up a reserve of strength against a future term of stress. I will not trespass on your patience much longer, but there are yet two matters remaining for me to refer to. I have alluded to the dark aspects of relief measures, but they have their bright side too. They promote a degree of sympathy and confidence between the people and their rulers, of which i would be difficult to overrate the advantages. They bring together, in the highest service of humanity, officers of almost every department of the Government and non-official gentlemen, natives and Europeans of every grade of life. English ladies also lend their help; and most valuable help I have found it to be. The political effects of the sympathy thus engendered—a sympathy which was illustrated and emphasised by the large contributions of money sent from this and other countries to the distressed districts—were very great, as coming from such a pure source of benevolence they ought to be. I have only one word more to say, besides thanking you for the patience with which you have heard me. The scope of his paper and the time at his disposal did not allow Mr. Holderness to make more than brief references to the great question of famine prevention in India. But I have since my return to England seen so much misapprehension displayed upon that great subject on the real condition of the Indian cultivators, and on the attitude and action of the Indian Government towards agriculture and industrial progress generally, that I am tempted to express the hope that, at some future time, Mr. Holderness will develop the allusions he has made this evening to these great issues. No one that I know is more competent to deal with them. My firm belief is that the balance struck by such an inquiry will be in favour of our administration. We have, doubtless, made mistakes, always with the best intention; our mistakes came mostly from the mistaken application to India of economic theories and legal conclusions which Western experience had approved. The results have worked in many ways contrary to expectation. I point, in illustration, to our judicial procedure, which, by rendering more certain the recovery of debt, increased the credit of certain classes, and thereby enabled them to sink deeper into debt. I point to the laws conferring proprietary interests in their holdings on ignorant cultivators who straightway borrowed money on the new security, and have since become the moneylenders' serfs. In such ways we have legislated in advance of social conditions, and we have not been always wise in our legislation. We are improving, but even now I question if we sufficiently recognise and allow for the simple fact that the Indian peasant, though personally thrifty, is socially extravagant; and that until his social habits, the influences which control him from his cradle to his grave, are improved and modified, our best-laid plans for his benefit may result in disappointment. The true Indian difficulty is not one of taxation—that is comparatively insignificant; it is not even one of precarious climate or unsuitable laws—these may be fought or changed; it is the social difficulty, the difficulty produced by the cumulative effects of religion, custom, and law, which place a premium on the growth of population, make extravagant expenditure a religious duty, and indefinite distribution of property a legal claim. Before regeneration comes to India the stringency of his social problem must be mitigated, or it must be solved in some way, and the true solution of it must come from the people themselves. But the Government can do much to help the solution forward—by an energetic educational policy, particularly of popular education; by the encouragement of all measures which make for thrift, and by the promotion of agricultural efficiency and industrial enterprise, whereby the standard of material comfort will be raised. If the efforts of Indian social reformers are seconded in this way—and it is, I know, the will and wish of Government so to second them—then I predict for India a bright and prosperous future.

Mr. F. R. Upcott, C.S.I., said the very sympathetic way in which Mr. Holderness and the Chairman had dealt with the construction of railways in the prevention of famine really left him very little to say on the subject. He wished, however, to seize this opportunity for pressing, as he had pressed during his thirty years of railway work in India, the great need of a more rapid expansion of the railway system. He did not propose to enter into the controversial subject of Irrigation versus Railways, but if it was true that the development of the industrial resources in India meant a gradual collection of a greater population in the manufacturing districts, we must cover that country with a network of railways as a first necessity. He noticed, in the yearly programme of railways which were put forward as new projects by the Government of India, generally, their commercial aspects came first; then came the military aspects;

and lastly, their value as a means of preventing famine. He thought the use of railways as a famine-safeguard did not always take that prominence which, in his estimation, it should do. They had in the railway department of India offered a very large and substantial programme of railways as a means of famine relief. Briefly, he would state what had been done in that respect. Up to 1900, in the Bombay Presidenc , there were ten projects, of an aggregate length of 314 miles, laid out for the purpose of famine relief, for earthwork and for the collection of ballast, which was about all the famine-stricken man could accomplish, the work being entirely unskilled. In the Punjab, there were put forward two lines, of an aggregate length of 254 miles. In Rajputana there were three projects, measuring 320 miles. In the Central Provinces there were three projects, totalling 984 miles, and in Hyderabad two, measuring 265 miles. That made a total of 1,750 miles, the famine labour being approximately about the value of £200,000. He regretted to say, however, that in that very long list of desirable railways not more than three of them had appeared in the programme for this year.

Mr. J. D. **Rees**, C.I.E., said he heard with relief that social reform which Sir A. MacDonnell held to be the panacea, was to come from the people themselves, because there was a school busily suggesting that this social reform, which was to be the salvation of the Hindoos, was to come from outside, and to be pressed upon them. How their standard of comforts was to be raised except by their standard of wants being raised, and how their standard of wants was likely to be raised so long as the Indian climate was to be the same, and when in ordinary years they had only to put out their hands and gather the fruits of the earth, he did not know. It seemed to him that there was every probability of the standard of wants remaining as it was now, and that there would be very little change except that which would result from the introduction of capital to which Mr. Holderness referred, and from the development of their own industries and the introduction of new ones. There was one custom which prevailed in India, that like many others had been so much misunderstood in this country, and that was purdah, which, some thought, was extended to Government officials. Mr. Holderness's paper was a proof to the contrary, and if officials came to the front, as they were doing on this subject, a great deal would be done to dissipate the great mass of ignorance which now existed.

The Rev. Dr. **Marks** said he had lived in Burma for forty years, where he had had the privilege of making the acquaintance of the Chairman, Sir Antony MacDonnell, who was one of the most energetic and successful rulers the province had ever had. As all were aware Burma was a country which knew no famine. The products of Burma were vast, and only recently the Government had telegraphed to the effect that over and above the necessary store for the proper feeding of the people there, they had a store of 2,200,000 tons of paddy, or rice, for export this year. The crop had been a record one; in fact, Burma had immense capabilities which only required development. In Burma, where they had such an enormous rice crop and wished to send it to India, they really ought to have a railway through from the one country to the other.

Sir **William Wedderburn**, Bart., said that the main subject of the paper was the administration of famine relief. Regarding that, he had little to say by way of criticism, and he would only express his respect and admiration for those who had laboured so well to mitigate the horrors of the situation. But they should remember the old proverb, that prevention is better than cure; and if prevention is better than cure, it is much better than mere mitigation. He was, therefore, glad that both Mr. Holderness and the Chairman had touched on the question of famine prevention, as distinguished from famine relief. Sir Antony MacDonnell had laid stress on the important fact that recent famines had been famines not of food, but of money. Even in the worst districts, in the worst weeks o famine, there had been abundance of food in the shops. This sufficiency of food was, no doubt, owing mainly to the railways, as pointed out by Sir Antony MacDonnell. Also it simplified the famine problem, which was reduced to the question, Why did the people die of hunger when there was abundance of food in the shops? The only possible answer to this question was that they were too poor to buy or to borrow. They had neither coin nor credit. Being hopelessly in debt to the moneylender, who was also the grain dealer, he would make them no further advances, so they had either to starve or be fed by the State. He (Sir W. Wedderburn), therefore, considered that the main duty of the Government was to investigate the economic condition of the cultivator, ascertain the causes of his great poverty, and so improve his condition that he may be able to tide over the failure of at least one harvest. He was very glad to see Sir Antony MacDonnell in the chair, as India was much indebted to him for his independent and far-reaching report. He hoped that the authorities would accept the co-operation of non-officials, who had, for some years past, pressed upon the Indian Government elasticity in the collection of revenue, and the establishment of agricultural banks, now recommended by the Famine Commission.

Mr. T. W. **Holderness**, in reply, said that he felt himself to be under great obligations to his audience for the kindness with which they had received him. When he was preparing his paper, he almost despaired of investing the subject with any interest, for it seemed to him that so much had been written and said about Indian famines, that there was nothing which he could add. He thought, however, that there was one merit which he might claim for the paper, and that was that it had elicited the masterly and comprehensive exposition of the fundamental questions involved in the treatment of the famine relief problem which the Chairman had just given them, and which everyone who had had the pleasure of hearing it, would agree was of the greatest interest and value. He ventured to express his general concurrence with what Sir Antony MacDonnell had said, and he regarded the speech as more than making good whatever deficiencies and omissions there might be in the paper. The gentlemen who had taken part in the discussion had dealt kindly with his paper, and there did not seem to him much that called for a reply on his part. Mr. Upcott was no doubt right in saying that there was no better work for famine relief purposes than railways. In the case of Rajputana, for example, the railway projects which had been surveyed before the famine were of the very greatest value for purposes of large relief works, and the same might be said about similar projects existing in other provinces and native States. He believed that it was the settled policy of the Government of India to maintain the fullest possible programme of such railway schemes ready for utilisation in time of famine. There was this difficulty, however, that although the earthwork of the railway line furnished admirable work for famine labour, the completion of the railway, which cost more than the earthwork, was outside the scope of famine relief, and had to be provided for by funds from the Railway Budget of the Government. It was not always possible immediately after a great famine to complete every railway, the earthwork of which has been thrown up by famine labour; and experience showed that under the destructive influences of the hot weather winds and the rainy season, a good deal of such half-finished work was liable to disappear. With regard to the railway to connect Burma with India, which one speaker had advocated, he agreed that the scheme might conceivably be regarded as within the sphere of famine protective measures, as such a railway would increase the existing means of communication between the two countries, and might enable grain to be brought with facility into some parts of Bengal. It was not, however, a matter of any urgency, as existing sea transport was cheap and well organized, while the cost of constructing the proposed railway was regarded by many people as almost prohibitive. It should be clearly realised that already an immense quantity of food came from Burma to India by sea in famine years, and sea carriage would continue to beat land carriage in the Burma-Indian trade, so far as the majority of the Indian provinces were concerned. The Bombay Presidency, for instance, received its supplies of Burma rice by steamers trading between the ports of Rangoon and Bombay, and no intercontinental railway could compete with this route in cheapness. With regard to Sir William Wedderburn's remarks as to the urgency of the question of famine prevention, and the necessity for improving the position of the cultivator, he felt he could add little to the recommendations on this head of the Famine Commission and to the observations which had fallen from the Chairman. It would certainly be an excellent thing if the position of every cultivator could be so improved as to enable them to tide over the loss of one harvest without coming on to the State for relief. But even as things were at present, a very large proportion of the cultivators were in this position. The people who crowded on to the relief works in the first months of the famine were not cultivators or small proprietors, but agricultural labourers. If the population figures of the several provinces were examined it would be found that at least 20 or 30 per cent. of the population were day labourers. The only way of helping this class in a famine was to find them special work, since ordinary agricultural work was in such a time at a standstill. In Berar, for instance, very few of the Government ryots came on to the relief works at all. This fact had to be taken account of when it was urged that if the land-revenue collections were postponed money would remain in the ryot's pocket which would keep him from the relief works. Land-revenue suspensions did not affect the labourer who has no land, and this was the class which practically supplied the relief population. In conclusion, Mr. Holderness again thanked his audience for listening to him with such patience.

The CHAIRMAN proposed a vote of thanks to Mr. Holderness, who briefly replied.

Sir GEORGE BIRDWOOD, in moving the thanks of the meeting to the Chairman, said it was always with a certain hesitation that he undertook this duteous service, for after listening to the reading of an informing and stimulating paper and an exhaustive discussion on it, the audience, in all his past experience of audiences in this room, were anxious to leave, and in these circumstances he had always felt that the dues of gratitude and courtesy toward the Chairman should rather be understood as offered and accepted than formally moved and voted, and acknowledged; and on the present occasion, after the admirable paper with which they had been favoured by Mr. Holderness, and the masterly remarks on it with which their distinguished Chairman had opened the discussion, he felt that he should be best consulting Sir Antony MacDonnell's own convenience by putting the motion entrusted to him (the speaker) to the vote without any preliminary compliments on either Mr. Holderness's paper or Sir Antony MacDonnell's speech, neither of which was he himself competent to discuss. Sir Antony MacDonnell, indeed, could not but recognise that the really significant compliment, both on his speech and his presence in the chair, was the unprecedented fact of the meeting having that afternoon kept together to hear and see the very last of their Chairman.

The motion was carried unanimously.

Mr. F. H. Skrine writes:—"The attitude towards famines of the ruling power in India reflects with accuracy the changes which have taken place in administrative ideals. Under the Mughal regime Musalman fatalism bowed its head before the Divine will, and made no sustained effort to cope with these visitations. In the early days of our own rule the same passiveness was maintained. The merchants on whom Empire was thrust were unversed in the art of government, and the idea of duty towards subject races was still in embryo. During the famine of 1770 no helping hand was extended to the starving millions, and a third of the population of Bengal was swept away. That the policy of *laissez aller* prevailed almost to our days is proved by the gross mismanagement of the famine which desolated the Upper Provinces in 1837-8. Higher conceptions came when the bonds between England and India were strengthened by the assumption of direct authority by the Crown. The fearful mortality in Orissa arising from the crop-failure of 1866 stirred the national conscience to its depths, and for the first time in its existence the Indian Government had to reckon with the voice of public opinion, at home. When famine threatened Behar eight years later, the Viceroy and his lieutenants had a free hand in dealing with the crisis: and the principle was laid down that human life must be saved at any sacrifice. The mandate was obeyed; but the methods adopted were immature, and the cost of relief almost prohibitive. Things were hardly better when the turn of Southern India came in 1877. At one period excessive waste held sway; at another, a still more reprehensible parsimony. But the experience gained was not thrown away. It was crystallised into a code, and our officers no longer groped in ignorance of the principles which should govern their action. The keystone was put to the arch of famine relief by Sir Antony MacDonnell, when he was confronted by a crop-failure as extensive as any of its predecessors. His efforts, seconded as they were by those of the entire body of his colleagues, elaborated a mechanism for combating famine as perfect as human faculties could devise. As our railway system brings the surplus of one province to fill a vacuum in food supply in another, we may fairly claim that this most difficult of problems has been finally solved. The lesson to be derived from Mr. Holderness's paper is, that the Government of India is a vital and a developing organism, capable of adapting itself to the increasing needs of the population and to the loftier ideals of public duty which come with a growth in civilisation."

Mr. Ernest Benedict writes:—"I cannot help mentioning my great satisfaction at Sir Antony MacDonnell's appreciation (and he is one who knows) of the educational value of Indian railways. Mr. Upcott regretted that "famine" relief works were stopped when famine ceased, but if they were all completed during years of plenty there would be none left to be done when the next famine occurred. Another speaker said, that the railway embankments thrown up as famine works and then abandoned, would be washed away in a few years. He is mistaken: they would be diminished in size by consolidation, and that is all. It would be an excellent thing if all new railway banks could be so left during two or three monsoons, for it would save an enormous amount of very costly rail-lifting, which, after the line is opened and ballasted, has to be effected with ballast. As a matter of fact, there is nothing so permanent in India as a mound of earth; witness the little bands dividing fields and the *sakhis*, or witnesses, the little heaps of earth at each corner."

Obituary.

G. F. Wilson, F.R.S.—Mr. George Fergusson Wilson, who died on Good Friday, 28th ult., was a very old member of the Society of Arts, having been elected as far back as 1845. He was a member of the Council from 1854 to 1859, and from 1864 to 1867; he was also Treasurer from 1861 to 1863. He was a frequent contributor to the *Journal*, and in 1852 he read a paper before the Society on the Stearic Candle Manufacture. In 1881 he placed at the disposal of the Council a prize of £5 for the best label for plants. This was awarded to Mr. Alment. Mr. Wilson renewed the offer, but confined it to a wooden label treated with some preservative preparation, and this time no award was made. Mr. Wilson was born at Wandsworth Common on March 25, 1822. He was one of the founders of Price's Patent Candle Company, and Managing Director until 1863, when he retired from the manufacturing management of the Company. His scientific work included the discovery of the means of obtaining pure glycerine, in connection with which he read a paper at the Glasgow meeting of the British Association in 1855. He was an enthusiastic amateur gardener and cultivator of lilies, and he possessed some twenty-five first-class certificates from the Royal Horticultural Society for his exhibits of various forms of the genus lilium.

Sir Sidney Shippard, K.C.M.G.—Sir Sidney Godolphin Alexander Shippard died at his residence, West Halkin-street, on Saturday 29th ult., aged 64 years. He was educated at King's College School, and went from thence to Oxford, where he obtained an exhibition at Oriel College, and subsequently a scholarship at Hertford College. Taking his degree in 1863, he was called to the bar as a member of the Inner Temple, in 1867. In 1873 he was appointed Attorney-General of Griqualand West, a post which he continued to hold until 1875, when he was made Acting Recorder of the High Court of Griqualand. From 1880 to 1885, Sir Sidney Shippard sat as a Judge of the Supreme Court of Cape Colony. In

1885 he became Resident Commissioner of Bechuanaland, and retired in 1895, when the Protectorate was abolished, and returned to London, where he became a director of the Chartered Company, and legal adviser to the Consolidated Coalfields of South Africa Company. He was elected a member of the Society of Arts in 1900.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

APRIL 9.—" Ceuta and Gibraltar." By MAJOR-GEN. JOHN F. CREASE, C.B. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, will preside.

APRIL 16. — " Photography as Applied to Architectural Measurement and Surveying." By J. BRIDGES LEE, M.A.

APRIL 23.—" Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S. SIR WILLIAM ABNEY, K.C.B., F.R.S., will preside.

APRIL 30.—" The Timber Resources of the Australian Commonwealth." By EDWARD T. SCAMMELL. SIR JOHN F. L. ROLLESTON, M.P., will preside.

MAY 7.—" Origin and History of Carriages." By ALBERT CHANCELLOR, J.P., Master of the Coach Makers Company.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 17.—" Recent Developments in Punjab Irrigation." By SIDNEY PRESTON, A.M.Inst.C.E., C.I.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab. SIR DENNIS FITZPATRICK, K.C.S.I., will preside.

MAY 8.—" The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT. SIR EDWARD A. SASSOON, Bart., M.P., will preside.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock :—

APRIL 8. 8 p.m.—" Street Architecture." By BERESFORD PITE, Professor of Architecture, Royal College of Art, South Kensington. THOMAS G. JACKSON, R.A., will preside.

MAY 6.—" The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27. 8 p.m.—" The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., " Glass for Optical Instruments." Four Lectures.

LECTURE I.—APRIL 14.—Optical images—Their nature and formation—Reflexion and refraction—Prisms and lenses—Conditions required—Spherical aberration — Astigmatism — Focal lines—Chromatic aberration—Achromatism—Distortion—The refracting substance—Glass and its manufacture up to 1882.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 7...Royal Institution, Albemarle-street, W. 5 p.m. General Monthly Meeting.

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Prof. Wrightson, " Weeds and their Eradication."

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. H. E. Bellamy, " Timber Bridges and the Woods used in their Construction."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. E. Sanger Shepherd, " Some Recent Improvements in the Photography of Colour."

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. W. Aumonier and Heywood Sumner, " Inlay and Marquetry."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Rev. F. A. Walker, " Locusts and Grasshoppers."

TUESDAY, APRIL 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Prof. Beresford Pite, " Street Architecture."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Allon Macfadyen, " Recent Methods and Results in Biological Enquiry." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussions on papers by—1. Mr. W. C. Copperthwaite, " The Greenwich Footway-Tunnel." 2. Mr. Arthur H. Haigh, " Subaqueous Tunnelling Through the Thames Gravel : Baker-street and Waterloo Railway."

Photographic, 66, Russell-square, W.C., 8 p.m.

WEDNESDAY, APRIL 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Major-Gen. John F. Crease, " Ceuta and Gibraltar."

Sanitary Institute, 74a, Margaret-street, W., 8 p.m. Dr. Patrick Manson, " Prevention of Malaria."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, APRIL 10...Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. E. Doran Webb, " Diary of a Minister of the Crown for 1690."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, " The Oxygen Group of Elements." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. Swinburne and Cooper's paper, " Problems of Electric Railways."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, APRIL 11...Royal Institution, Albemarle-street W., 8 p.m. Weekly Meetings, 9 p.m. Prof. Dewar, " Problems of the Atmosphere."

Astronomical, Burlington-house, 8 p.m.

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. Grant, " An Apparatus for Vapour-pressure Measurements." 2. Mr. Morris, " The use of Cathode Rays for Alternating-Current Measurements." 3. Mr. Morris, " An Experiment on the Current Growth in an Inductive Circuit." 4. Dr. R. A. Lehfeldt, " An Electric Heater." 5. Mr. S. A. F. White, " Note on the Compound Pendulum."

SATURDAY, APRIL 12...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Cummings, " British National Song." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, April 14, 8 p.m. (Cantor Lecture.) Richard T. Glazebrook, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." (Lecture I.)

Wednesday, April 16, 8 p.m. (Ordinary Meeting.) J. Bridges Lee, M.A., "Photography as applied to Architectural Measurement and Surveying."

Thursday, April 17, 4.30 p.m. (Indian Section.) Sidney Preston, C.I.E., "Recent Developments in Punjab Irrigation."

Further details of the Society's meetings will be found at the end of this number.

APPLIED ART SECTION.

Tuesday evening, April 8; Thomas G. Jackson, R.A., in the chair. The paper read was "Street Architecture," by Beresford Pite, F.R.I.B.A., Professor of Architecture, Royal College of Art, South Kensington.

The paper and report of the discussion will be printed in a future number of the *Journal.*

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal,* cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 9th, 1902; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Aburrow, Charles, M.Inst.C.E., F.G.S., Johannesburg, Transvaal, South Africa.
Carver, Thomas Albert Briggs, B.Sc., 118, Napiershall-street, Glasgow.
Chesney, Cummings C., Stanley Electric Manufacturing Company, Pittsfield, Massachusetts, U.S. America.
Davis, Brinton B., Paducah, Kentucky, U.S. America.
De Vinne, Theodore Low, 300, West 76th-street, New York, U.S. America.
Dodge, William Earl, 99, John-street, New York, U.S. America.
Dyer, Bertram L., Public Library, Kimberley, Griqualand West, South Africa.
Edington, Alexander, M.D., F.R.S.E., Colonial Bacteriological Institute, Graham's Town, Cape of Good Hope, South Africa.
Foo Choo Choon, Lahat, Kinta, Perak, Federated Malay States.
Fritchley, Edwin Wollaston, F.S.I., 6 Sirdar's Palace, Hummum-street, Fort, Bombay, India.
Greenhill, Thomas Arthur, Assoc.M.Inst.C.E., M.I.M.E., Santa Teresa, 9, Madrid.
Henderson, Joseph J., M.I.M.E., 689, Tenth-street, Brooklyn, New York, U.S. America.
Higgins, John, County Engineer, Greymouth, New Zealand.
Johnston, Augustus Fredric, Assistant Engineer, North Western Railway, Shikarpur, Sind, India.
Paine, Robert Treat, 6, Joy-street, Boston, Massachusetts, U.S. America.
Ridley, Hon. Matthew White, M.P., 36, Portland-place, W.
Sale, Charles V., Messrs. Sale and Co., Limited, No. 167, Yokohama, Japan.
Veeder, Major Albert, M.D., Broad-street and Queen-street, Lyons, Wayne County, New York, U.S. America.
Wales, Nathaniel Young Armstrong, Messrs. Mason and Wales, Dunedin, New Zealand.
Walker, David C., Gibbonsville, Idaho, U.S. America.
Walker, John Shaw, M.Am.Soc.C.E., Railway Department, Perth, West Australia.
Wilcken, A. F., care of Standard Bank of South Africa, 10, Clement's-lane, E.C.

The following members were balloted for, and duly elected members of the Society:—

Anderson, Robert Hay, Assoc. M. Inst. C. E., M.Am.Inst.M.E., 1a, Independencia Num. 9 (Apartado Postal 866), Mexico City, Mexico.
Bennett-Goldney, Francis, F.S.A., Abbot's Barton, Canterbury.
Crouch, Archer Philip, 106, Cannon-street, E.C., and 24, Micheldever-road, Lee, S.E.
Gray, Charles, 4, West Regent-street, Glasgow, and Rossarden, Kilmalcolm, Renfrewshire, N.B.
Kennedy, John, 11, Fellows-road, N.W.
Kitson, Arthur, The Kitson Lighting Company of Great Britain, Limited, Blackfriars, E.C.
Lanza, Professor Gaetano, 22, West Cedar-street, Boston, U.S.A.
McBryde, Professor John McLaren, Ph.D., LL.D., Virginia Polytechnic Institute, Blacksburg, Virginia, U.S.A.
Miller, Frank S., Manor House, Old Malden, Worcester-park, Surrey.
Payne, Hon. George, J.P., M.L.A., Durban, Natal, South Africa.
Rollo, James Theodore, Superintending Engineer, P.W. Department, Maymo, Burma.
Tomlinson, Frederick John, Riverdale, Manor-road, Teddington.
Wall, Charles, Ashburnham Works, Lots-road, Chelsea, S.W.
Walser, Conrad, 28 and 29, Cheapside, E.C.

The paper read was—

CEUTA AND GIBRALTAR.

By MAJOR-GEN. JOHN F. CREASE, C.B.

The consideration of two fortresses like Gibraltar and Ceuta, the subject of this paper, at first sight may seem a little foreign to the intents and purpose for which a Society such as is represented in this theatre was established, but when one considers the vast interests in connection with the mercantile section of our country involved in the safe-keeping and guarding of the entrance into the great inland sea, the securing of the approaches to Malta, and the establishment of and our firm hold on that great Island Fortress and naval arsenal, the integrity of Cyprus, together with the safety and free use of that strip of water, the Canal, leading to our Indian Empire and great Colonies beyond the sea, then we realise in some measure the importance to this country of the firm possession of one of the very first links of the chain which binds our Empire together, and renders possible a most useful application of that sea power we have sacrificed so much in the past and present to obtain.

I do not propose in the limits of a paper such as this to enter into the histories of those countries in which the Fortresses of Gibraltar and Ceuta are situated, more than is absolutely necessary for the purposes of illustrating the particular value such strongholds would possess for us in the present day, to point out as clearly as I am able their strong and weak points, and to give Gibraltar in particular no more than its due importance in sustaining the reputation it has obtained in the past of being an impregnable Fortress, and therefore as such, from its position merely, the key of the Mediterranean, which, truly or falsely, is the popular impression in this country. My aim is to show how far that impression is based on fact, an impression which, if not correct, may lead perhaps in the not distant future to a state of affairs which may affect injuriously our own national safety, the maintenance of our power in the Mediterranean, and those paramount interests, National and Mercantile, which would seem to be so intimately involved in it.

Gibraltar has, as everyone is aware, been long considered as the key of the Straits. Assaulted and taken by Admiral Sir George Rooke, in 1704, with a fleet of 45 battleships and a landing-force of 2,000 Marines by partial surprise, it has withstood, and successfully, all attempts at re-capture. It has long served as a stepping stone to Malta, and, above all, has afforded, on more than one occasion, a refuge for our fleet in time of trouble; from it we have been enabled to patrol the entrance of the Straits, and in a measure command, by our Navy stationed at it, the narrow waters which lie immediately in its front; in this way it has acted as a sort of key by which our Navy could close the Straits, unless to an enemy present in overwhelming force. It has furnished in the past a rendezvous for our fleets for provisioning, and in a measure also, a haven of safety for re-fitting after an action at sea whenever temporarily outnumbered and overmatched they had been compelled to take refuge under its guns.

It has also afforded protection to such of our naval and commercial vessels and convoys as have from time to time required such aid, and has usefully served as a point for concentration, whence hostile operations could in safety be organized and carried out. For all these purposes it had, as long as our fleets could anchor there in safety, a value hardly to be over appreciated. The question, however, which has to be decided now, is how far this so-called impregnable fortress is available at the present moment, for a further discharge of such important conditions as described; can it perform them at all? Is it really available, or are we relying falsely on the glorious traditions of its past, and blinding ourselves to the fact that the enormous strides which have been made in the power of attack over defence, in the development of artillery fire, steel armour, and high explosives, have not altogether altered the condition of affairs, and rendered Gibraltar no longer useful for those purposes which, with the aid and by means of our fleet, in the past it so perfectly fulfilled?

The mere fact of the impregnability of Gibraltar as a Fortress, if it be impregnable (which from a combined sea and land attack is far from the case) is a matter of little real consequence to this country, the question which has to be decided is—what is the practical value to us of its so-called impregnability, if it really exists? If it has no value other than this one particular claim, if it does not afford in addition ample protection to our Fleets when from some temporary disaster or weakness, such protection becomes requisite—its mere impregnability is absolutely useless to us. Can our vessels of war and merchant ships dock, coal, and refit there, out of fire and in safety from attack? Any impregnability which Gibraltar may possess, if it will not afford this sort of protection, and fulfil this one all important function in time of war, is a snare and a delusion. It can be of little use to us to be able to say that we have shut up 5,000 well-drilled soldiers on a rock, and that no one can turn them out of it. The cost of the maintenance and keep of these troops in such a spot under such conditions, would be little repaid by such a return, for the risk of their lives or for the expenditure of our money. The real point to be considered is evidently, will this fortress *protect our fleet*, can it be made useful for Naval and Commercial purposes, and if not, then the men and money so bestowed in the defence of this rock, notwithstanding any fancied claim to impregnability, are men and money wasted and of no avail.

Coming to the conclusion, as long ago as the end of the year 1883, that the altered conditions of warfare before alluded to, had considerably modified the value to us of Gibraltar as a Naval Port and Depot, a fact which was realised neither by the Government of this Country nor by the Country itself, the writer of this paper went to Gibraltar, and, on his own responsibility, inspected and reported on it, both to the Admiralty and the War Office. What he found as regards the serious deficiences and shortcomings of the Fortress is beside the question, and outside the limits of this paper; he discovered, however, that it was by no means as strong as represented, and what is more to the point, that it had no protected harbour where ships could anchor in safety from gun-fire or torpedo attack, no effective Dockyard in which ships could, after an action, be refitted, and no dock in which a ship could be placed for any necessary repairs. The only coaling place which, in case of war with Spain or with any of her allies, could be made available, was at the New Mole—alongside of which only two ships could lie and be coaled at one time—and the New Mole itself had accommodation for only 4,800 tons of coal under cover, a very serious matter where it is understood that the Coal Hulks to the North of the Bay by the Neutral Ground, in war, would have ceased to exist.

The writer found also that the whole of the New Mole and the Dockyard inside it would, in case of war, be exposed to the fire of guns, not only from the shores of the Bay right round from the neutral ground to Carnero Point on its southern extremity, some miles in extent, and nowhere more than 10,000 yards distant, but also that its interior portion was quite visible from, and commanded by, the heights across the neutral ground, and by the Queen of Spain's Chair, only 6,000 yards away. Coaling or refitting at the New Mole under such conditions, it is needless to say, would in time of war, be therefore a practical impossibility, and Gibraltar so conditioned, would be evidently useless to our Navy and Mercantile Marine as a Port of Refuge or of refit. Of what use then its impregnability, if it really were so, would be to this country, is left for my hearers to decide.

A Report in accordance with these facts was sent in to the Government. It pointed out most clearly and strongly and without any reserve all these weak points, together with many other very serious defects in the Fortress not mentionable here. It strongly urged that any impregnability of Gibraltar as a Fortress could only be usefully considered from a naval and not from an entirely military point of view, that if it failed to afford protection and aid to our Fleet it was practically useless to this country; further, that a protected harbour and dock was an absolute and vital necessity.

The Report went further to show that to

build such a port on the Western or Gibraltar Bay side of the Rock would be a waste of money, seeing that such a harbour would of necessity be commanded not only by modern gun-fire from the shores and heights of the Bay all around, but also by a flanking fire at comparative short range from the heights beyond the Neutral Ground. An alternative harbour, it was suggested, should be built on the eastern side of the Rock, preferably by Europa Point on the Mediterranean side, containing 95 acres of water (as shown in the plans), this being the only point on the eastern side of the Rock where a safe entrance to such a harbour could be assured in any weather, where it would not be affected by the moving sands which exist further to the north in Catalan Bay, and at the only spot, also in the whole Rock, where such a harbour would not be exposed to direct fire from anywhere on the Land side of the Fortress.

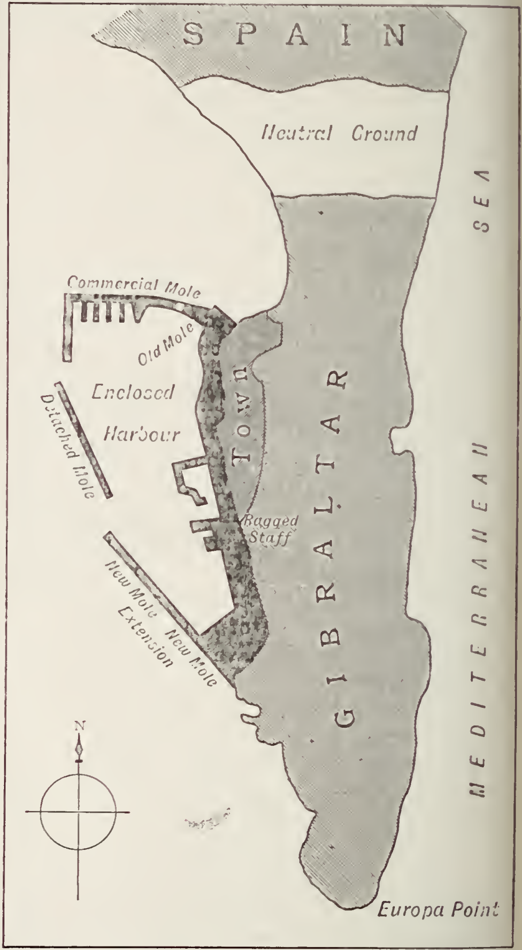
This Report was sent in to the Admiralty and to the War Office in March, 1884, and was the beginning of the agitation in Parliament and elsewhere, for a harbour and dock at Gibraltar. The absolute correctness of the whole of the statements made in this Report have been thoroughly substantiated by recent events, and it is clear that had the advice given in it been adopted in 1884, some £2,000,000 or £3,000,000 of the £6,000,000 sterling to be spent on the western harbour, would have been saved to the country. The writer's report was very briefly acknowledged at the time it was sent in, by the War Office and Admiralty—nothing more then or since.

The history of the creation of a protected harbour and dock on the western side of Gibraltar is well known. In the years 1893-94 the matter became urgent, directions were given by the Government to build them on that side. When the Gibraltar Docks question came again before Parliament, in 1901-2, it was pointed out that it would be folly to continue the building of a harbour and dock where they would only be useful in time of peace and not in war. In reply, it was stated by the Government that there was no time to build such a harbour anywhere else. A committee was sent to Gibraltar by Lord Selborne, to inquire into the subject of a dock and harbour on the east side of the Rock, and the result of this visit was a report to the effect that, at some time or other, such a harbour would have to be constructed. Meantime, as such progress had been made with the Western Harbour, it could not well be discontinued, it was therefore determined to complete the work.

As to the question of want of time to build an eastern harbour and dock it must be understood that the plans for an Eastern Harbour were placed by the writer of this paper in the hands of the War Office and Admiralty in March, 1884, eighteen years since.

It will be understood clearly, with this new Western Harbour and Docks built and building at Gibraltar on its Western or Bay side, that any coaling or repairing, or refitting of ships in its docks, dockyard, wharves, or harbour, in case of a war with Spain (from whom we took the Fortress) or with any Power in alliance with Spain, will have to be carried on, if at all, within easy range of modern guns which can be placed on every point, from the Queen of Spain's Chair right round the whole extent of the

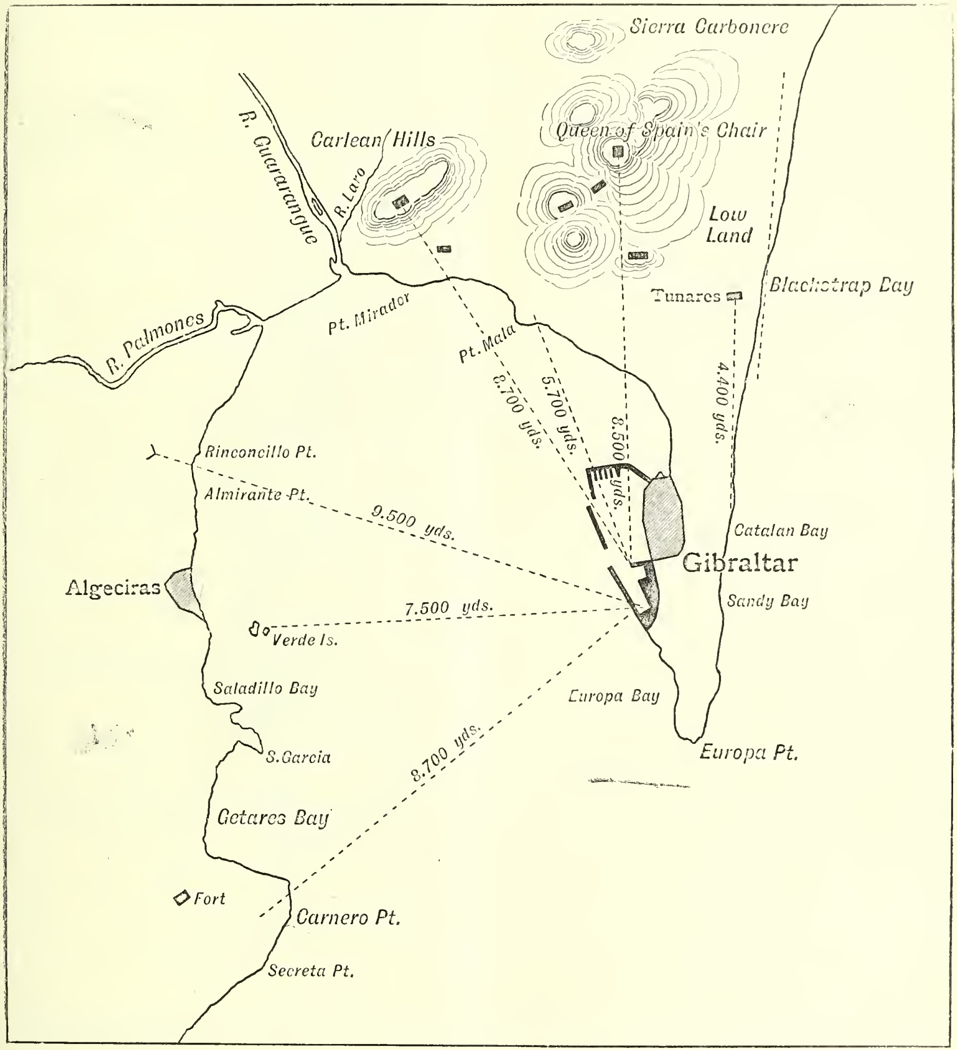
FIG. 1.



Walker & Cockerell sc.

Bay to Carnero Point, that a Railway Station exists at Algeciras opposite to Gibraltar, from which all the capitals in Europe can be reached, and by which troops and war material (in any quantity) can be brought from Madrid, Paris or Berlin, and that, should such a state of affairs ever come to pass as a war with one or more European Powers, we shall, in order to be able to use our western harbour and docks, be compelled before doing so, to occupy strongly all the Spanish territory commanding them, a necessity which will require the exhibition and use of a force of certainly not less than 50,000 men. Aware of these facts, one naturally asks of what use would the mere impregnability of Gibraltar as a fortress be to us in such a position?

Fig. 2.



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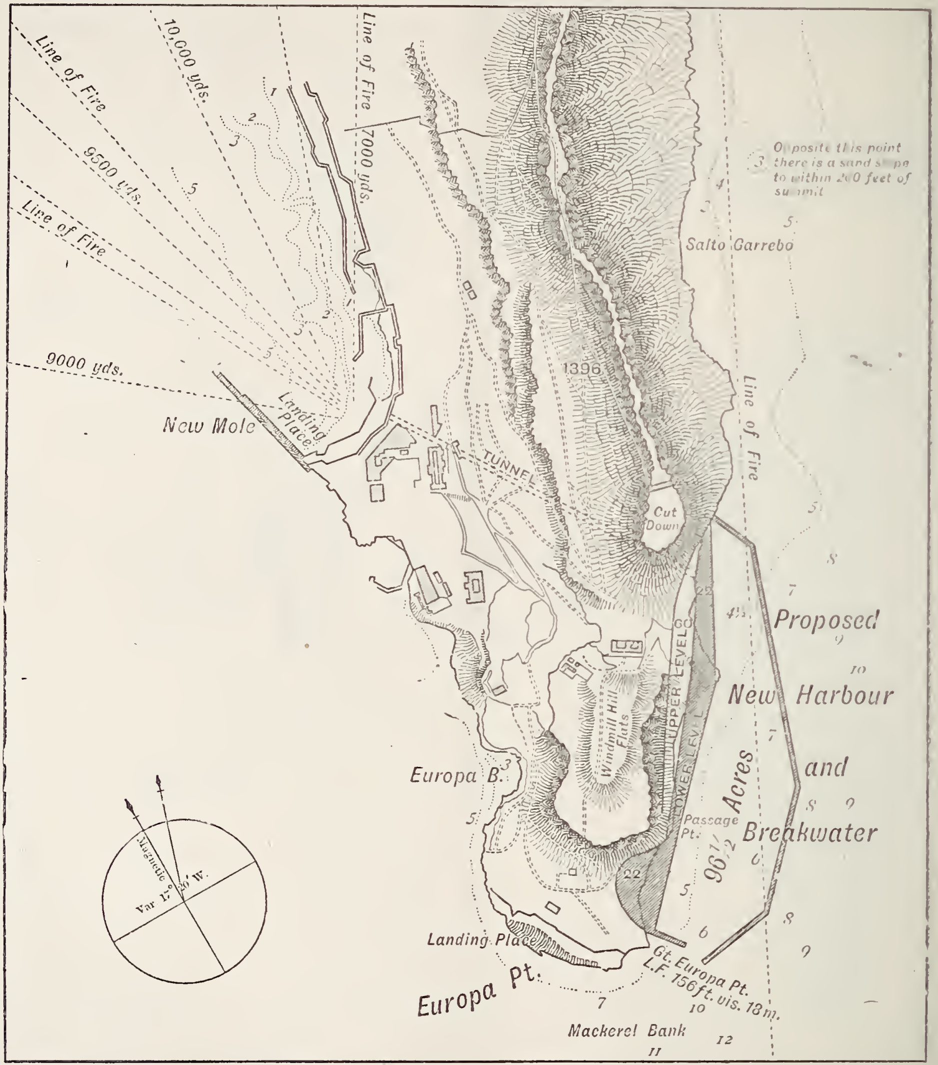
But there are other serious considerations which seem to render our hold upon Gibraltar somewhat precarious, and its impregnability more a matter of sentiment than reality; there is the very urgent one of food and water supply, and the disposal of its civil inhabitants, mustering, and living at present inside the fortress, in numbers, excluding 2,000 aliens, no less than 17,000 souls. Water can always be obtained by storing up the rainfall in tanks (there are no springs) and by distillation of sea water, but the providing of food is a matter of very much more serious and urgent consideration.

Gibraltar is nearly all rock, there are a few spots in it where earth has been carried and coaxed into gardens, and on the Heights there is one place where there is arable ground of very small extent indeed, and which has been dignified by the title "Ince Farm." There are, in fact, in the fortress not more than 15½ acres under cultivation. In the great siege there was a very great difficulty experienced in supplying the garrison with the vegetables necessary for the health of the troops, most of the necessary green food being obtained from small vessels which ran through the Straits at night from the opposite coast of Morocco, and which brought over as well fresh meat for the consumption of the garrison.

FIG. 3.



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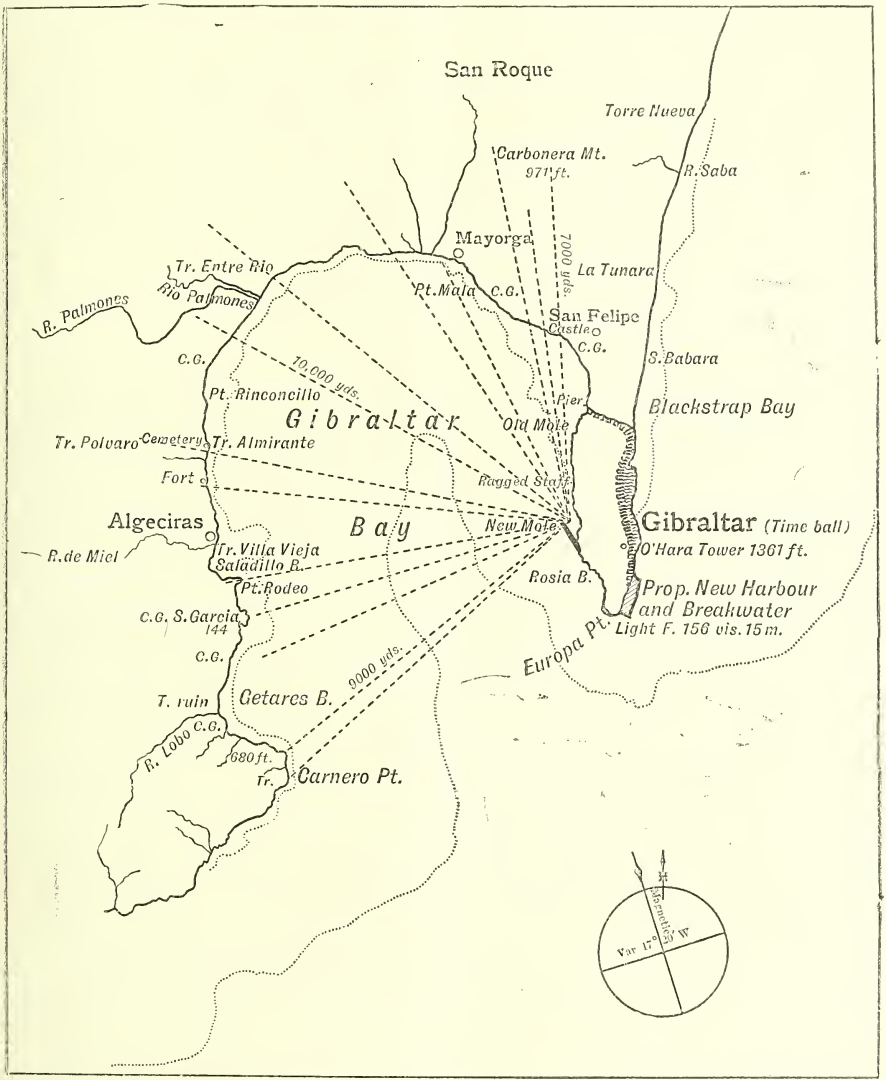
SKETCH SHOWING NEW HARBOUR AT GIBRALTAR.
Designed by Lieut.-Col. Crease, C.B., and which accompanied his printed report to the Admiralty and War Office, dated March 4th, 1884.

In any modern attack on the fortress, by sea as well as land, which, of course, would mean the absence of our fleet through defeat or other cause, all supplies from outside sources would at once cease, for steam would render a blockade less difficult than in the olden days of sailing vessels. Without a harbour protected from fire, with a large population and no means of feeding them except from provisions, private and public, stored up in private cellars and in garrison warehouses, the whole Rock under fire of modern artillery from every available point, with little or no cover for the inhabitants but what could be obtained by actually tunnelling into the solid rock, the position of the defending Garrison and population of Gibraltar would be anything but a pleasant one. The destruction of any naval or mercantile ships taking refuge in the present new Western Harbour would be a matter of absolute certainty, and, of course, in such a predicament, any title or claim to impregnable Gibraltar being the key of the Mediterranean would entirely be lost. If we have always in the Mediterranean an overwhelming naval force, the ships comprising which will require neither docking, coaling, nor refit, nor any chance of a reverse, or a weakening by the necessity of the withdrawal of ships which may be urgently required elsewhere, then Gibraltar as a fortress might not be necessary at all. But the idea of supporting such a fortress as Gibraltar is based entirely on the assumption that it should be able to afford to our ships

FIG. 4.



SKETCH OF GIBRALTAR BAY AND FORTRESS, SHOWING NEW HARBOUR.
By Lt.-Col. Crease, C.B., and which accompanied his printed report to the Admiralty and War Office, dated Mar. 4th, 1884.

assistance in time of trouble and defeat, to enable a partially disabled fleet to recruit and repair damages in safety and covered from attack. Such a reversal of the order of things as that the main function of the Mediterranean fleet should be to prevent the attack and capture of Gibraltar by sea, has in no wise ever been contemplated, the very *raison d'être* of the fortress is that it should be able to protect our fleet in case of need, and afford it help when necessary; if it does not do this, then Gibraltar is worthless to this country.

It is very certain, therefore, that a Harbour, Dockyard, and Dock must be made on the Mediterranean side of the Rock, otherwise, if we are to use the place at all as a Naval Station in time of war, we must be prepared to seize upon and occupy all the Spanish territory commanding the Bay and Rock, and this unforeseen circumstances at the time might render impossible.

The idea which the English public has held from old time is that Gibraltar is impregnable by land and sea, can never be taken from us, that it is in some mysterious way the key of the Mediterranean, that the safety of our fleets in the Mediterranean, nay, our very existence as a Nation is insured by its occupation. The English public quite forgets that the main function of Gibraltar is to provide a harbour of refuge, a coaling and docking station for our ships, that the Straits being of a certain length and width can only be closed by ships and not by forts, that there are other points in it which may possibly be more desirable to obtain, and which would fulfil our requirements quite as well, if not better, than Gibraltar itself, and though it would be possible, I say possible, so to defend Gibraltar that we could hold it, we could only do so were it fully provisioned and watered and filled up with latest military stores and guns, and provided also the civil inhabitants were withdrawn, and the Rock tunnelled in every direction for casemates in which the garrison could live secured from fire ; new batteries would also have to be installed, provided with all the latest types of ordnance and ammunition, and the defence of the fortress remodelled. It might then, I say, be held, but of what use to us the Fortress, so held, would be without a protected harbour in which to refit, repair, and coal our fleet, one fails to realise. As well fortify a rock in the middle of Sahara Desert, and keep that because it might be impregnable. To this country either would be equally useful under such ridiculous conditions as I have endeavoured to describe.

Looking at the map of Gibraltar and Bay, it will be seen that the Rock consists of a long ridge running north and south, rising perpendicularly at its northern extremity to a height of 1,300 feet, from the narrow strip of sand which connects it with the mainland; this ridge, precipitous on the eastern side as far as O'Hara's Hill, 1,600 feet in height, slopes towards the sea on its western face, and on the northern end of this slope is built the town. Beyond O'Hara's Hill to the south, the ridge sinks abruptly to what are called the Windmill Hill Flats, from 200 to 300 feet in height, and from these Flats, the ground again falls abruptly to the Europa Flats, from 60 to 70 feet in height ; at its extremity is a lighthouse, beyond which the end of the Rock, falls, from the height mentioned, abruptly into the sea.

The entrance to the town from the sandy isthmus (at the northern extremity of which are the Spanish lines, separated from our lines by the neutral ground between them) is guarded by strong continuous fortifications extending from the shores of the bay to the Rock itself, which towers over them. All along the side of the Rock, and flanking these lines, are skilfully made batteries with an inundation in front, and higher up still, cut out from the solid rock, are the celebrated galleries (mounted with heavy artillery) which, entering the rock at a considerable height above the ground, extend right across the northern end of the ridge to its eastern face, and command all the ground over which any approaches across the isthmus to the Town Lines could be made by any attacking force. The fortress here is of enormous natural strength—the Spaniards called it the "Gates of Hell"—and, doubtless, this matchless position at its northern end, gives to the place the reputation it has gained for impregnability. At the shore end of the Town Lines, and flanking the approaches to them from the north, is the celebrated Old Mole, built in solid masonry out into the harbour. This Mole played a very important *rôle* in the great siege ; it was, for that period, heavily armed, and obtained from the Spaniards on account of its biting power the well-earned name of the "Devil's Tongue." It would be almost impossible for any enemy to take Gibraltar by assault from the neutral ground.

Looking upwards towards the heights from any point below them, on the western shores of the ridge, one sees, half way up the slopes, a sudden precipitous rise of over 100 feet of bare rock, separating the slope into two distinct parts, an upper half and a lower one. Midway between the northern extremity of the ridge and O'Hara's Hill, are two walls about 100 yards apart, built from the summit right down to the edge of the upper slope; one of these walls was erected by the Moors, the other by the Spaniards, the object being to prevent an enemy passing along the upper slopes from O'Hara's Hill to the northern extremity of the Rock overlooking the defences of the town. Between these walls, on the summit of the ridge, is the Flagstaff battery, which latter sees along and commands the eastern side of the Rock, and overlooks Catalan Bay.

The whole of the eastern side of the ridge from the northern end to its southern one, is precipitous, but in Catalan Bay, as far south as O'Hara Hill, the moving sands, washed up by the sea on to the beach, are blown by the winds right up until a natural slope of 45° is formed against the face of the Rock, and this reaches to within 150 feet of the summit. From under O'Hara's Hill to Europa Point there is no beach, nothing but precipitous rock. The Flats, however, at this point bend away to the south-west in such a manner that from O'Hara's, as far as Europa Point, the end of the Rock is invisible from the Neutral Ground to the north, and it is consequently covered from any direct fire of guns from the mainland, by the slopes of O'Hara's Hill. On the eastern face of this part of the Rock the writer of this paper proposed to build an Eastern protected harbour and dock.

Examining the shores of the Bay it will be observed that at the north end of the connecting isthmus of sand on the main land, are heights of considerable altitude. It was on the top of one of these, so tradition has it, that the Queen of Spain sat down to see the fortress captured by her army, in the great attack by land and sea, made during the celebrated siege. The spot whereon she so sat was in a very commanding position, and from the circumstance has ever since been named "the Queen of Spain's chair." It is to be noted that from this spot, and from others besides, not far distant, a complete view of the town and sea lines is obtainable; all the interiors of the batteries along the whole sea front, right up to the New Mole, are commanded from about this point,—the New Mole being only 6,000 yards distant. Batteries of heavy modern guns placed here would render the town and sea faces of the fortress practically untenable,—no ships could anchor, coal, or dock in the new Western Harbour without being exposed to a searching fire from this point. Looking further around the shores of Gibraltar Bay, it is seen that the ground rises gradually in broken flat ridges, suitable in many points for batteries, as far as the town of Algeciras; and beyond that the country becomes more bold and hilly, terminating at the southern extremity of the bay in a bold headland called Carnero Point, which has in its rear, and commanding it, heights of still greater altitude.

Nowhere along the shores of this bay is it more than 9,000 to 10,000 yards distant from the Rock, in some places less, and round the whole of it can batteries be built, from which Gibraltar in every part, save to the eastward of Europa and Windmill Hill Flats, could be shelled with ease and certainty, every point on the Western side of the Rock being visible from the shores of the Bay to the naked eye.

Comparative Power of Old and New Guns.

In the good old days, when Gibraltar was, so to speak, satisfactorily impregnable, we had no guns larger than 24 or 32 pounders, throwing a spherical shot of that weight to an effective distance of, perhaps, 1,500 to 2,000 yards; we had 10 inch mortars and 6 inch and 8 inch carronades with hollow shot for short ranges. At this period the anchorage off Grbraltar was out of range from the Spanish shores, and not exposed to fire. Two fleets could anchor in Gibraltar Bay, and each one be out of range of the other, indeed, such a thing did actually occur on more than one occasion; then, indeed, the fortress, impregnable, afforded complete protection to any fleet anchoring under its guns. Contrast that happy time with the present day. We have now guns which, mounted on high elevation carriages, can give to their projectiles an air penetration of over nine miles, and which even at that distance can, by means of telescopic sights, be aimed with tolerable accuracy.

The new land service 9·2 in. BL.X gun, weighing 28 tons will, with 103 lbs. cordite, throw a shell weighing 380 lbs. with a bursting charge of 30 lbs., over nine miles. Contrast the effect which would be produced by these guns with an old 24 pounder, the ordnance then in vogue. The land service 12 in. of 46 tons throws with a charge of 295 lbs. a shell weighing 714 lbs. with a bursting charge of

77 lbs. of powder. Turning to Naval guns, we have the 15·25 in. gun of 111 tons weight which, with a charge of 96 lbs. of powder, throws a shell weighing 1,800 lbs., with a bursting charge of 78 lbs. of powder, and the 12 in. of 50 tons which, with a charge of 211 lbs. of cordite, throws a shell of 850 lbs., which has a bursting charge of 81 lbs. Again, fill these shells with high explosives, the bursting effect of which is simply terrible, picture them rained upon a fleet anchored or berthed in the present new Western Protected Harbour and upon the Yard and Docks—and then exercise your own plain common sense, and ask yourselves the question how could a fleet repair, refit, coal, or dock in such a position exposed to such a fire—what would the workmen do? how long would the coal stores remain intact and unconsumed? Why in 24 hours everything would be burnt up—stores, factories, and town, the Fleet also most probably destroyed by the high angle fire; most certainly no useful work could be attempted, nor could any ship be docked—the position of a Fleet so placed would be hopeless unless they at once went to sea or anchored to the eastwards of the Rock, where they would be exposed to torpedo attack, and where then would be the protection afforded by the Impregnable Fortress?

Let us go a little further—we have manufactured 36 in. mortars, constructed them in cast-iron sections so as to be easily transported (there is no difficulty in the present day in manufacturing them in steel); these mortars are intended to be fired with spherical shell. Imagine three or four such ordnance set up in batteries which could be built on the splendid positions which are to be found for them on the heights just beyond the Neutral Ground. I ask what would be the effect of the fire of such ordnance on the town and harbour works of Gibraltar, throwing 36 inch spherical shell filled with cone pressed guncotton, which, if they struck on the slopes of Ridge, would roll downwards on to the batteries or the town below,—the effects of such a fire would be terrible in the extreme.

There is an answer to all this, it is true, viz., that the Garrison would reply to such an attack by a fire equally searching and powerful, but still, it would be under different and disadvantageous conditions, for example, the whole length of the rock from north to south on which batteries can be built and guns mounted, does not exceed 2¼ miles in length, every point along the Rock for this distance can be plainly seen from everywhere around the Bay, and from the heights, to the north of the Rock. No battery could exist anywhere along this space, where it could not be detected. Further, the bare rock does not lend itself to the building of batteries, and so such erections being difficult to arrange, are therefore the work of time. Given, however, forts having mounted on them the most powerful and effective guns now made, only a certain number of them can be so placed, and from the nature of the ground must be so situated that whatever shot or shell happened to miss any particular battery, would be bound to hit some object somewhere on the slopes behind or in front, and damage something. On the other hand, the enemy's batteries would be placed where shot striking short, would do no damage, and when they passed over would simply deposit themselves harmlessly in the country beyond. Another point to be considered is that an enemy would have more space and greater length of front in which to mount his guns, the shores of the bay being 11½ miles in extent, he could therefore mount more guns, more widely spaced, and in safer and unknown positions, he would be possessed of the still greater advantage in being able to concentrate his fire on all or any of the well-known weak points of the Garrison, on spots where his fire would produce the greatest damage, and this would be a distinct advantage not shared with an enemy, by the garrison so attacked.

It is very evident, therefore, that although under the conditions I have already stated, of casemated tunnels driven into the solid rock, our troops were they fed, a very difficult matter, and supplied with unlimited ammunition, they could hold Gibraltar and prevent its being captured by an attack from the land. But such a holding of this post under such conditions would be the incurring of a useless expenditure of life and money, and waste of time, could we not repair, refit, dock, or coal our ships in the present new Western Harbour in time of war. To use such harbour we should be compelled to occupy the heights to the north of the Neutral Ground, and the heights commanding the Fortress on the shores of the Bay all round, which, as has been stated, would necessitate the employment of 50,000 men at least, to do so effectively. Of what use then, I repeat again, would the impregnability of Gibraltar be to us? None at all, for the ground we should then have to defend would not be the Fortress, but away from it, and in a measure outside its influence altogether.

Consequently, although we can use our Western Gibraltar harbour most usefully in time of peace, we shall not be able to do so, under present conditions, in time of war, when its use will much more urgently be required. Should Spain be unfriendly or allied with any Power with whom we might be at war, our position would be compromised. The Western Harbour, therefore, possesses not only a serious weakness, but as it exists at the present moment is *also a distinct menace to Spain*. Its use to us being obligatory during war, it follows that, whether Spain be willing or not, we shall certainly, in case she objects, have to appropriate, occupy, and hold such of her territory as commands it, and so ensure the free use of our harbour and docks to ourselves.

One solution of this difficulty seems to be the construction at once, at Gibraltar, of a protected harbour out of fire on the Eastern or Mediterranean side of the Rock. Referring to the plan it will be seen that a harbour made to the eastward of Europa Flats would be out of direct fire from anywhere on the main land, and would enclose 96½ acres of water; there is no sea at this point which in the heaviest gale would be destructive to such a work, and which could not be controlled. The depth of water is most suitable for the construction of a breakwater, and wharfage to the extent of 1,000 yards could be obtained; entrance into the harbour could be made by any steamship in perfect safety during any sort of weather. The rock for the construction of the Breakwater could be cut from the top of O'Hara's Hill, and tumbled thence into the sea below, it could be drawn thence for use as required. On the flat quarried space so obtained on the top of the hill casemated sanitary barracks and batteries in the very best position that could be selected for the purpose could be erected for the protection of the harbour. A tunnel, should it be necessary, through the rock would connect the harbour with the dockyard, no *débris* would be required to be removed from the harbour site during its construction, nor would the Harbour or Breakwater, as before stated, be in any way injuriously affected by the moving sands, which are found north of it opposite Catelan Bay, and which, blown up by the wind from the beaches where it is continually being deposited, has formed a long natural slope of sand, before alluded to, which reaches up the cliff from the water's edge to within 150 feet of its summit.

The prompt action of the present First Lord of the Admiralty in sending out a committee to Gibraltar to enquire into this subject, argues well for the effectiveness of his administration in time to come, few First Lords would have had the common sense, or, above all, the moral courage to act as he has done under very difficult circumstances, and such action will certainly procure for him the confidence and respect of the Services generally, and very certainly that also of the British Public.

So far the Fortress of Gibraltar has been dealt with, and I think it has fairly been shown that unless it will give shelter to our fleet in time of war, any impregnability which it may enjoy from attack by land (it clearly is not impregnable if attacked as well by sea), will not justify its being kept up by us as a Fortress, the more so that under such conditions as at present (seeing that it cannot harbour a fleet in safety from an enemy's fire) it is no more a key of the Straits than Portland or Guernsey, or Alderney would be a key to the English Channel were our fleet non-existent. For it is by the action of the fleet only that the Straits can be sealed, and it must be noted also that even if we do build an Eastern or Mediterranean Harbour the accommodation is limited, and the building of it is not to be entertained if we can procure a better and more available spot elsewhere, more suited to the demands which very certainly some day will be made upon it; and which does not compromise our position with a Power with whom we should be on friendly terms.

Whilst at Gibraltar, the writer determined to visit Ceuta on the Morocco side of the Straits. Hearing that the presence of foreign officers at that place and at that time, was considered by the Spanish Authorities undesirable, it was realised that such visit might be attended with certain inconveniences, and a very talented officer of Royal Engineers, Captain Georges, kindly consented to accompany the writer across the Straits. Permission to land and see the place was at once granted, the only restriction being, that the visitors were to be accompanied by someone deputed to be in attendance for that purpose. Opportunity was taken on the evening of arrival to witness a large theatrical performance, given by a special company imported from Spain, a box next that of the Governor of the Fortress being secured for that purpose, the House being crowded with all the local celebrities, official and otherwise, from the Governor downward. The following entire day was devoted to inspecting all the forts and fortified posts, admission to which was most courteously granted. On the ensuing morning, early, the Straits were recrossed, no opportunity, therefore, offered itself for calling upon and paying our respects to the Governor, and thanking him for the unique privileges we had enjoyed. The original programme, however, laid down for interviewing a Moorish Chief, was rigidly carried out, much useful information from him and others as to the wishes and intentions of the Moors themselves, being thereby obtained. The only thing which struck one in connection with the Spanish troops, was their intense appreciation of a well-made cigar, their general smart appearance and soldierly carriage, and the fact that all the sentries on duty wore green gloves, apparently of kid.

The history of Ceuta, as a Fortress, Citadel, and Stronghold, would fill a volume of itself, a precis, therefore, of the events in connection with this important old time fortress, is added to this paper in the shape of a short Appendix, together with a similar history of Gibraltar. It is sufficient to state here that Ceuta has stood many important sieges, one of 25 years duration, the traces of which remain visible to this day, in the shape of iron shot lodged in the brick-made walls of the older Moorish portions of the town defences. These Lines, though of limited extent, are remarkable, as regards their more modern portion, for their intricate trace, and the care which evidently has been bestowed on their general design.

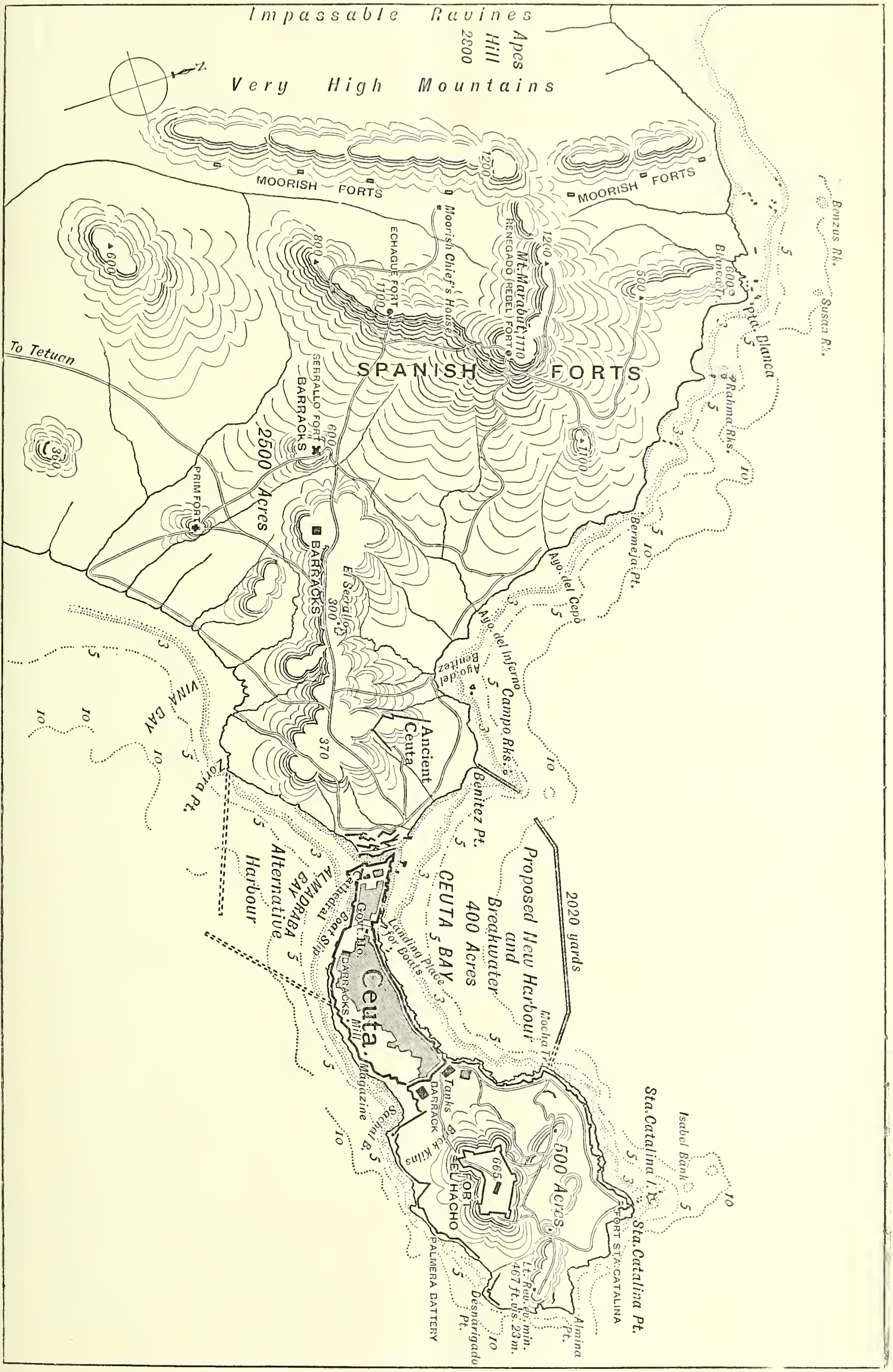
Ceuta is a Spanish possession, and referring to the plan it will be seen that it is situated on the African coast immediately opposite to Gibraltar, and being nearer than that Fortress to a line drawn through the middle of the Straits parallel to its respective shores, it has from its position a greater command of them. The fortress of Ceuta consists of an island-like projection, some 500 acres in extent, 700 feet in height, joined to the mainland by a narrow curved isthmus which falls from a height of some 200 feet on its south side to the sea on its northern shore. On this Isthmus is built the town, which is defended at its entrance on the west, by old Moorish Lines, supplemented by more modern Portuguese or Spanish ones in stone, bearing date A.D. 1630. The island-like projection referred to, on the summit of which is a strong citadel, is seamed with deep ravines, which are commanded by it. The shores of this projecting knob of land, which are bold and abrupt for their whole circumference, afford no landing place, and the cliffs, which are not of any considerable height, are lined along their summits with a stone wall on which there are placed one or two old cast iron rifled guns. The peninsula, which is of rock, is covered to some depth with a clayey loam very suitable for making good bricks, for building Batteries and Barracks, and for other useful purposes.

The ground on the mainland where the Isthmus joins it, rises at some 500 or 600 yards from the Works covering the entrance to the Town, to a height of 370 feet, and then falls in the shape of a ridge, with ravines on either side, extending to the sea, to a point 1,000 yards distant, towards the West, where it is 500 feet in height, from which point it again rises gradually at first, and then almost precipitously to a Range of Hills, in distances from the Citadel about 7,560 yards, and from 1,100 to 1,200 feet in height. This range of hills commands a deep valley situate immediately in its front, which bounding the Spanish territory, and separating it from that of the Moors beyond, extends in a northerly and southerly direction each way, from the Straits on the one side, and the Mediterranean on the other. On the western side of this ravine, and extending for a considerable distance from the Straits to the southward, are very high mountains (2,800 feet) and impassable ravines; to the southward these latter broaden out, and terminate in a tolerably open plain on the Mediterranean shore.

The harbour of Ceuta, on the northern side of the Isthmus, although possessed of fair anchoring ground, is not a particularly good one; it is exposed to northerly and north-easterly winds, which here, however, are neither very strong nor prevalent. It is covered from easterly, south-easterly, and south-westerly gales, but at such times the water in the harbour is much disturbed, and precludes any landing, which can only be done at any time from boats, and at one point in the Bay, where there is a small projecting stone pier and boat slip, commanded by an open Battery of six 24 pounders, the rest of the circumference of the harbour being lined by a sea wall some 20 feet in height from the water edge, against which, although the water is very shallow close up to it, the sea breaks in heavy weather with some violence. On the South side of the Isthmus the holding-ground is good, and the water deep up to the shore, but as this part is much exposed to southerly and south-easterly gales, it is seldom utilised for anchoring purposes, and its extent likewise is limited.

The town which, from its position, is necessarily of small dimensions, is clean, its drain-

Fig. 5.



Ceuta.

Walker & Cockerell sc.

age is superficial, all dirt being shot over the sea wall into the harbour. Drinking water is obtained from wells and from cisterns also, in which rain water is collected. At the entrance to the peninsula are two large reservoirs, into which is drained the rainfall collected from all the large areas close to them, including parts of the Town. This water is used by the townspeople for washing purposes, and for watering some of the streets during the hot season.

The business portion of the Town seems to be confined to one section of the main street, in which are a few shops. No provisions are allowed to be exported, and very little, if any, trade seems to be carried on either from the Port or through the Lines, the business of the former being confined to the supplies necessary for the inhabitants and Garrison, and that through the latter to provisions and fuel. The advent of strangers being by no means encouraged, accommodation is limited, and primitive in character. At one of the hotels it was observed that whilst breakfast was was laid for the guests at one end of the coffee-room table, treble-manned beds for the male domestics, not over clean, nor supplied by Maple, were made up at the other. The Peninsula of Ceuta, as stated, is formed of limestone covered to some depth in places with clay loam, which latter is very productive and eminently suitable for making bricks and tiles for which it has been, and is still, extensively used. Some specimens of bricks in the old Moorish walls were exceedingly good, as were those also recently made and being utilised for building modern Forts and Barracks.

The peninsula offers excellent sites for barracks. Screened by the formation of the ground from the fire of ships, it is naturally a very strong position, could be easily defended, all the materials for cheaply constructing strong batteries capable of resisting the most modern ordnance, existing on the ground. There were many gardens visible, and the crops on them seemed to be exceedingly good. In one of the ravines were a number of what looked to be pine trees. The writer was informed that there were springs of water on the place.

The Lines at the end of the town opening towards the country are commanded by those heights, immediately outside which terminate the ridge beyond. The original Moorish and interior portion (the strongest) are in brick, and have a wet ditch in front of them, through which the sea passes in the shape of a deep canal, and over which is a bridge. The exterior portion of the Lines are Spanish or Portuguese, made in stone and of less altitude than the interior ones; all are armed with 24-pounders, some in bronze, others in iron, and as defensive works would, thus armed, and seen from the higher ground immediately outside, be formidable only against the Moors.

Beyond the Lines the soil is of the same character as that in the peninsula, but under it slate stone is found as well as limestone. The land itself is capable of the highest cultivation, and with the best results. A very good road runs to the summit of the ridge and up to the Positions beyond them, which is so directed as to be commanded by the fire of forts if necessary. The ridge contains excellent positions for batteries, which, well-placed, would render any advance to the town from the most advanced lines, if captured, a most difficult operation.

The Spanish Hill Boundary Line, which is crowned by a number of well placed small circular brick forts, is an *exceedingly strong position*. These hills form a range commanding a deep ravine in front, and are so situated as to support and flank each other. The mountains in the Moorish territory across this ravine, which extend along the whole front of the Spanish position from the Straits to the southward, are precipitous and traversed with practically impassable ravines, and the establishment of batteries anywhere on them which would injure or command any forts or buildings on the Spanish territory in the neighbourhood of the Town would be very difficult, if not impossible. Facing the southern portion of the Spanish position towards the plains are detached hills, well placed and crowned with small forts. These not only command the ground immediately in front of them, but also that in rear of the outermost Spanish positions, and would render any advance of an enemy from them, if captured, a very trying operation.

The small towers in brick with which the summit of the hills are crowned, are surrounded with shallow, dry ditches, crossed by short narrow, removable bridges. Each of the towers has a cellar, a living room on a level with the entrance, an upper storey, and above that again, a flat roof, surrounded with a moderately high brick parapet, 12 inches in thickness, over which the defenders can fire. All the rooms are loopholed for musketry, no provision has been made for artillery fire. The towers are of two sizes, the larger ones being garrisoned by a sergeant and twenty men, the smaller ones by a corporal and ten men, the relief taking place once a week. All the barracks built between the outermost lines and the inner ones immediately outside the Town, are made defensible and arranged for flanking fire.

The whole of the Spanish position facing the Moorish territory is one of extreme natural strength, and if surmounted by forts of modern trace, and armed with modern artillery, could not well be captured, as from the nature of the ground, except towards the sea, only light guns could be brought to bear against them. The outlying portion of Ceuta could not be attacked with any chance of success by land, it could only be seriously so assailed from the south, and such attack would be rendered all the more difficult were not the attacking force masters of the sea, as from ships the siege batteries of the attacking force, did it select the best position in which to place its artillery, could be seen into, and taken in reverse by heavy naval gun-fire. The fortress in the Peninsula could not be attacked from the land side as long as the outer Lines, of immense natural strength, were giving help, and attacked from the sea. Unlike Gibraltar, the deep ravines are capable of affording natural cover for the troops, without the aid of casemates or other artificial means; in them 5,000 or 6,000 men could camp in safety from artillery fire, unless the place were bombarded from every side at one time; and even then there is one point in the peninsula where effective natural cover could, to a great extent, be obtained. The entrance to the Peninsula is narrow and commanded; the huge reservoirs for fresh rain water at the junction of the isthmus and Peninsula form a very effective obstacle capable of extension and being further improved upon.

Were a Breakwater made at Ceuta, so as to protect the Bay on its northern side, facing the town, as suggested on the plan, the harbour so formed could be entered in safety in any weather, and a fleet could anchor in it protected absolutely from torpedo attack. The length of such a Breakwater would be about the same as that proposed to be built on the eastern side of the Rock of Gibraltar, but would enclose 500 acres of usable water instead of 96 acres, the amount obtainable at the latter place; such a Breakwater would cost less to make and keep up than that at Gibraltar, as it would have less work to do, being constructed in a position less exposed to the action of the sea.

The water lots, which would extend from the town wall to the four fathom line in the harbour, would, were it an enclosed one, become a valuable property for the building of wharves, &c., and in the end pay much towards the formation of the Breakwater.

A Dockyard and Dock could be established at three of the points. The first by Almadraba Bay offers the advantage of deep water close up to the shore, and the high bluff behind it would protect from the fire of any batteries established on the land side, but docks here would necessitate the cover of a Breakwater for which the place is unsuitable, seeing that the entrance to the harbour so formed would be difficult and dangerous in heavy weather, when its use perhaps would be most required. Near Benitez point a dockyard would be exposed to the fire of ships cruising in the Straits to the Eastward.

The opposite side of the proposed new harbour would seem to be the best situation in which to locate a Dockyard; at the point to the west of Port El Hacho there is a deep ravine, which, running into the hill, would afford an excellent site for shops, &c., entirely invisible and protected from the fire of ships, unless they anchored close to the northern extremity of the outermost line of Forts, where, of course, they would be exposed to a heavy plunging fire at a short range, from the advanced batteries, as well as to the dangers of shoal water.

In the construction of a Breakwater rock would be required, and if selected from this ravine, in common with other suitable spots, advantage might be taken of its removal to render the already natural cover afforded in this place still more perfect. A Yard and a Dock placed here would also have the advantage of being away from the Town and in the Fortress proper, a very desirable thing in every way.

To quote the exact words of the report with regard to Ceuta, made to the Government:—

"With a good and safe harbour with wide and spacious wharves which would be established, and with ample space outside to grow, Ceuta, ruled by a firm and liberal Government, could not fail of becoming one of the Emporiums of North Africa. With the facilities the place could afford for discharging and taking in cargoes, and for coaling, it would become a port of call to all the ships leaving and entering the Mediterranean. Its climate is almost perfect, and the damp and heavy feeling which is experienced at Gibraltar during the Levanters is here unknown. On the hills around are various springs of water, and the ground inside the Spanish lines and on the Peninsula, is extensive and productive enough to supply with food, independent of the country outside, both town and garrison; with these enormous advantages, a good harbour, an excellent site for a dockyard and dock, with all the means of pushing trade and so forming, without any prejudice to its naval and military position, a free and commercial town with the most effective means possible at hand for cheaply building forts suitable for modern requirements, and one of the very strongest positions in the world in which to put them up, with a friendly population in the country all about, and a climate that leaves nothing to be desired, Ceuta is a port which, commanding the Straits even more effectively than Gibraltar itself, should rivet the attention of the Government of this Country."

Comparing Ceuta with Gibraltar, as a fortified advanced post and a harbour of safety for our Fleets acting in the Mediterranean and along the south coasts of France and Spain, the advantages are greatly in favour of the former place.

The harbour which could be made at Ceuta would be one of much greater capacity and more useable than any which could be made at Gibraltar, less exposed also to attack either by sea or land. Both eastern and western harbours at Gibraltar would be open to attack from the sea, and the Western or present New Harbour could be assailed from the sea and from the land as well.

If we were at war with France, and Spain were our Ally, we could at Gibraltar, if attacked by sea, obtain provisions from Spain. But we should not be able to get any from Morocco, for France would at once seize upon that country together with Ceuta. France is at present in a position to take Morocco whenever she chooses, if we do not occupy Ceuta, and Europe does not interfere. France has so developed and strengthened herself in Algeria, has so extended the Algerian railways towards her Moroccan frontier, that such a seizure could be easily carried out. But were we at war with France, and perhaps some other European Power at the same time, it is tolerably certain that France would compel Spain to refuse us any assistance in the way of provisions, and not impossibly to attack us from the land side of Gibraltar as well; in such case if our fleets were unable to relieve the garrison, it would, with the population it has to sustain, amounting to 19,000, besides its garrison of 5,000, be certainly starved out. There is a law existing in the place, that every inhabitant is responsible for the provisioning and storing up of a certain quantity of food in his own residence in case of accidents, but laws and regulations of this sort soon fall into disuse, and in modern wars the notice given before their outbreak is a very short one, in our case probably, there would be none at all.

Gibraltar has, including the North Front, an area of 1,266 acres, of this amount 15¼ acres only are under cultivation; this fact goes to prove how very much the fortress must depend on outside help in maintaining its garrison and population in the many necessary food products which cannot be stored.

Were Morocco occupied by France, and Ceuta seized upon by her, its capture by us would be next to impossible. France would then be stronger in the Straits than ourselves, better placed and less exposed to attack, seeing that the question of want of provisions for her garrison would never arise. Her Fleet also, would be better protected than ours at Gibraltar, and less exposed to attack; the injury she could inflict on our trade, so situated, would be enormous, the communication with and use of Malta would be much hampered, and the canal except to warships, which would have to pass the Straits in force if at all, would practically be closed to our merchant fleet altogether.

In the last French war we occupied Ceuta for a certain time, in order apparently to prevent its seizure by the French. We were omnipotent at sea in those days, and even then this precaution was necessary,—how much more so is it necessary now (when France is strongly and firmly settled in Algeria and so strong as well by sea) that we should be permanently and strongly established in the fortress in question if we wish to preserve our Mediterranean and Eastern trade. This country must realize she has not a single reliable Ally in Europe, and that she may be opposed to two or even three Powers at one time; so placed we are bound to look possibilities straight in the face, and provide for what it is possible, nay, it is even probable, may happen in war. Spain still looks upon Gibraltar as of right belonging to her; it is ours by conquest, but it is a part of Spain, not even separated from it by a canal of water, and more than once has its restoration to Spain been seriously considered by this Country. The Spaniards are a proud people, though at present, as a nation, they are enfeebled and weak; at one period, however, not so very long since, Spain had the finest infantry in Europe, and overran a great part of it; what has happened may do so again. Spain may recover her power, she may not always be down. Her feelings with respect to Gibraltar are just as keen as ours would be were Portland to be held by the French. The possession of Gibraltar, therefore, will always be a sore point between ourselves and a nation that may in future be a thorn in our sides. We may discount Spain at present in any coalition against us, but strong or weak, she will always have some sort of influence for or against us, and a national feeling besides, which, should ever opportunity occur, might be exercised dangerously to our best interests. At Ceuta, none of these conditions would exist, we could obtain it by treaty by a fair and just exchange of Ceuta for Gibraltar. We should be infinitely stronger by doing so, and what is more, in a much better position to maintain our commerce and to resist agression in the Mediterranean, also to neutralize the effects of any emnity which might be displayed by the only nation which at present on the sea we need take into serious accouut.

Were Spain at Gibraltar she would be no more powerful to do us (or any one else) harm than at Ceuta; nor could anyone take it from her as long as we were her Ally and firmly established in the latter fortress. In such a position we could prevent her being attacked at Gibraltar from the sea as well as successfully by land. If Spain in possession of Gibraltar were allied, however, with any other European Power inimical to us, and Gibraltar were occupied by that Power, it might give trouble, seeing that now there is a covered Western Harbour where an enemy's fleet could take refuge. Had this harbour not been built, Spain in possession of the fortress and allied or not with any enemy to us would have been powerless for harm. A harbour on the western side of the rock is the most available one which could be built for Spanish uses, seeing that any batteries established on the shores round the bay would help in its defence, commanding as they would, the approaches to it; and moreover, all the conditions which now so militate against its use by us would only confirm it as a possession for Spain. The making of such a harbour at Gibraltar, by us, was a folly hard to explain away, but if we had to attack a Spanish ally, or Spain herself in Gibraltar, in its present condition, it would not be much more difficult than if we had to defend it ourselves; for in either case we should have to seize upon and occupy the shores of the bay, an operation which would be just as difficult for us to carry out either for the defence or the attack of the fortress in question.

On the other hand, Ceuta cannot be assailed with any chance of success by an enemy from the land side; any approaches to it on that front must be made from the south, and all Lines or Batteries so established can be seen from the sea and taken in reverse by artillery fire from ships.

The only thing which can be said in favour of the western harbour at Gibraltar is that it is useful in time of peace. Its establishment, however, must prove to Spain clearly that under any circumstances we intend it for use, also it clearly indicates that we are prepared to go to war with Spain, if that be necessary, to ensure the free use of the harbour in the production of which we have spent so much money. With such a potential threat hanging over them, the Spaniards would not, I think, hesitate to give Ceuta in exchange for Gibraltar, an exchange by which both parties to the bargain would be much benefited. Nothing short of the occupation of Ceuta by Great Britain will prevent annexation of Morocco by France, and France once in possession of that country will not be satisfied with anything short of the occupation of Ceuta, and Spain must be as aware of this fact as she will be impotent to prevent it. Such an unfortunate circumstance would, however, be a deadly blow dealt at our Eastern trade and commercial interests in the Mediterranean, a blow from which we should find it most difficult to recover.

MOROCCO.

Morocco, ancient Mauretania, is practically to Europeans a *terra incognita*; with us it is associated with Tangier (once English), or with Ceuta or Tetuan, into which latter port once a year perhaps, some personally conducted excursion steamer casually enters. The names of its other trade ports we recognise only when some article in connection with them brings their remembrance to us. Occasionally we read of a massacre or threatened revolution in some of the wilder parts of the country, which is met by a notice in our daily papers to the effect that war vessels have been despatched to some of the treaty ports for the protection of vested and other interests, and there the matter ends. Our Consuls, Government officials, Travellers and Scientists sometimes venture a visit to Marrakesh (as it is called by the Moors, Morocco by us) or to Fez the second capital city, and some others, for instance, Hooker and Ball, have penetrated with difficulty beyond Marrakesh to the edge of the southern ranges of the Atlas mountains, other travellers such as Harris in 1896, Fisher in 1899, have given us their valuable experiences—such as they are—of those parts to which strangers under protest are unwillingly admitted. De Foucould, in 1884, the only traveller who has apparently been able to penetrate (at the risk of his life) to parts unknown to us before, tells of a country furnished with magnificent snow-clad mountains with fertile and well watered valleys between, inhabited by a hardy race of mountaineers, with date-growing plains, and deserts stretching beyond to the south. Meakin, who has written two most valuable books—"The Land of the Moors" and "The Moorish Empire"—books which are standard works on Morocco, and should be read by all students interested — adds also a learned and exhaustive treatise to the Moorish literature of the day, but although Stanley and others have lifted the veil from some of the long hidden secrets of the great Central African table-lands and forests, and the shrill whistle of the locomotive in the heart of Africa now divides the honours, with the calls of the beasts of prey, yet the Riff and that portion of Morocco immediately to the north of, and containing most of the Atlas ranges, are really less known to us now than they were probably to the Romans and Carthagenians, or to Europe generally in the times of the Moors in Spain, at which period slaves, long resident in Morocco, did sometimes escape, bringing to us strange tales of the customs and manners of the Moorish people, and of the hardships they had undergone at the hands of those amongst whom their miserable lot had, happily for them, been only temporarily cast.

The history of Morocco from the beginning is one of bloodshed and misrule ; every change of sovereignty has for the most part been heralded by war, and inaugurated by murder and rapine. The Leader who could commit the most bloodthirsty actions and most piously flood the country in blood, in the name of Allah and his Prophet, has been the one whose empire has been the most firmly established, and who has obtained the most saintly reputation in the national records of his country.

All along the immediate borders north and south of the Atlas Range, from Cape Judy right up to Flemcen, on the frontiers of Algeria, (which country is inhabited by warlike hill tribes,) together with that portion of land on the borders of the Mediterranean known as Er Riff, is forbidden ground—the Sultan of Morocco himself cannot enter either portion except with an army, and even then he cannot go far. The only portions of Morocco that can be traversed by strangers or in any way exploited, are those in the immediate neighbourhood of the open ports and their Hinterland, together with the narrow strip which lies between the mountains immediately to the southward of the Riff, and to the north of that portion of the central and south-west Atlas Ranges, and which stretches, as before stated, from Rabat on the west to Algeria on the east, in which strip of land is also found the Imperial cities of Mequinez and Fez, together with the towns of Taza and Oodja, which latter town from its situation on the frontiers of Algeria must be of importance in the time to come.

The Empire of Morocco consists of two portions, one which has Marrakesh (Morocco) for its capital, the other which seems more particularly to appertain to Fez. In the early days these two capitals were under what was practically separate rule. The original, and to all intents and purposes still dominant race in Morocco, are the Berbers, who are evidently split up into tribes ; advantage seems to have been taken of this in the early history of the kingdom by the Arabs, who coming from the deserts beyond Atlas, Egypt, Syria, and Arabia, invaded the country and overcame and conquered the Berbers. The Berbers, however, who have notwithstanding been always a dominant race, held their own, and from time to time in the past history of Morocco, have risen upon their masters, and often with success. Like the Scotch in Great Britain, they have conserved their nationality in their apparently unapproachable hill fastnesses, whence upon either side, on Morocco to the north, and towards Sahara on the south, they have made themselves felt, and even now, though under the nominal rule of the Sultan of Morocco, they still retain all their old national characteristics, and still defy entry by outside strangers of any description, into the mountain recesses which have given them birth.

The open trade ports of Morocco, taking them from east to west along the coast, are as follows :—Tetuan, Tangier, La Raiche, Rabat and Sla, Casablanca, Mazagan, Saffi and Mogador.

There are as well closed ports on the Atlantic Coast, by name :—Asila M'ambra, Mansurya, Fedala, Azamur and Wallidiya, which ports, some day it is to be hoped, may also be opened to trade. There are also some so-called sacred towns, three in number, and to the south of the Atlas ranges are the provinces of Sus, having as principal towns Tarudunt and its seaport Agadir, Wad Nun, and beyond, The Draa-Figig (the oasis recently occupied by the French), and farther to the south again the oasis of Tuat; of these, Sus and Tafilat (the great date-growing country) are the most important.

All Morocco is naturally most fertile. Cereals can be grown to any extent; more than enough to supply the whole of this country. Cattle can be bred and fed in any quantity, and the great mineral wealth of Morocco is beyond question. Copper is found almost pure; doubtless silver and gold also exist. We read in history that on one occasion one of the Sultans of Morocco obtained at one time as much as forty loads of gold dust in tribute; one of the Sultans named Abul Allah, to avert a disaster, made an offering to the tomb of Mohammed at Medina of as many as 23 Korans in gold cases, studded with 2,300 rubies and precious stones. But what is still more important there is to be found without doubt, and doubtless in some quantity, coal. Captain Warren of the Royal Navy, who resided for some time in Morocco, informed me that he himself had seen and handled it, and believed that large fields of it existed in some parts of the country.

Morocco has no roads worthy of the name, nor bridges over the many important streams which find their source on the snow-clad Atlas mountains, consequently the interchange and transfer of goods and produce from one part of the country to the other is a matter of time and difficulty; worse still, the rates of exchange in the country are so varied and unsettled, the title to property so insecure, that merchants have little opportunity of developing trade, which, under more favourable conditions, might swell to enormous dimensions; add to all these difficulties a taxation, to be measured only by the capabilities and length of the purses of those who are compelled to pay them, together with the necessary protection money which is demanded by the various tribes, through whose territory goods of every description have to be carried, and we can form some idea of how merchants are handicapped, who in trading attempt to, and do, gain a good livelihood in this misgoverned Empire.

There is little doubt but that if the English were established at Ceuta, the means of export for the almost unlimited productions of the country would at once be provided, for Ceuta in our hands would become a port of call for every steamer entering or leaving the Mediterranean. Gibraltar at present supplies every year over 500,000 tons of coal to more than 5,000 merchant steamers. More than 9,000,000 tons of shipping year by year enter and clear from its bay. All these vessels were we at Ceuta would follow the flag. The Moors are an intelligent and hardy race; the Berber portion of the population are mountaineers. Helped by England at Ceuta with the necessary capital, and taught by her to develop the enormous natural resources of the country by the introduction of good public roads and railways Morocco would become a perfect mine of wealth. With magnificent ranges of snow-clad mountains, the fertile and well-watered valleys and plains could produce food enough for this country in the shape of corn and cattle to render us in case of war independent of all other countries; her mineral wealth must be inexhaustible. Firmly and fairly ruled and with European organisation and discipline, the Moors would make admirable soldiers, quite capable of guarding and keeping intact and independent, their most defensible country. Morocco would make as neutral a splendid buffer State against foreign aggression. Holding Ceuta, England would really be the possessor of the key to the Mediterranean; and the pass to Malta to the Canal and to her Empire beyond would be absolutely secure. Under the ægis of a Mohammedan as well as a Christian Power—which England really is—the Moors would feel that their religious opinions and creeds would be respected and cared for; the advent of England at Ceuta should give no real cause of offence to any other Power, for the fortress would have been obtained for her, not by annexation or conquest, but by the fair exchange of another for it of equal value and position, nor could any exchange be more suitable for Spain, a Power who would naturally wish by such a bargain once more to secure her own. England in Morocco would be a benefactor to Europe in as much as her presence at that spot would ensure the continued independence of the Moorish nation, and so prevent a dissolution of that Empire, and the disturbance to the balance of the European Powers which would very possibly be caused by it, and finally, still more to the purpose, there would be a throwing open to the trade of Europe, a country, whose natural resources can only be bounded by the trouble which may be taken to develop them. England, alone of the Powers at Ceuta, can provide an outlet for the legitimate energies of a nation whose place in the past in art and war guarantees its ability, under proper rule, to take a commanding position in the present. England alone can be trusted to open and keep open to Europe the Moroccan trade door, at Ceuta only can England secure to herself such a position in the Straits as is necessary to her continued dominance in the Mediterranean Sea, and so procure in a peaceful and rational manner, what in the future will otherwise very certainly have to be purchased at the expense of a costly and bloody war. Ceuta, in England's hands, would become the Emporium of the whole of the trade of North Africa, and a source of wealth to this country not to be over estimated, even in the present day.

Finally, summing up the facts which the writer had endeavoured to place before his hearers as to the comparative advantages and disadvantages to this nation involved in the holding of Gibraltar or Ceuta, for the purpose of commanding the Straits, guaranteeing our present naval position in the Mediterranean, preserving the integrity of the vast commercial interests involved in it to this Country, and to our great Colonies beyond the sea, it must be evident with respect to Gibraltar:—

(*a.*) That it can only be of any real practical use to us in time of war, if Spain be neutral or acting as our Ally.

(*b.*) That under present circumstances Spain would almost inevitably be forced to be hostile to this country; if not openly so, then secretly ready to become so, should any favourable opportunity enable her, even with some danger to herself, to assume that position.

(*c.*) That if Spain were hostile, and we seriously engaged elsewhere, Gibraltar would become next to useless to us in war.

(*d.*) That should an Eastern harbour be made at Gibraltar as suggested, even then it could only afford a partial solution of the difficulties involved in its retention.

(*e.*) And that Gibraltar in the present time of peace seems simply capable of discharging only the function of a coaling and docking station for our fleet, that it has not now, possibly never will possess any commercial value to this country, notwithstanding the enormous tonnage of steamers which make it a constant port of call.

With respect to Ceuta, its advantage to us over Gibraltar as a port and fortress would be as follows:—

(*a.*) Its safety would be quite unaffected by any war we are engaged in with any European Power or Powers.

(*b.*) The friendly exchange of Gibraltar for Ceuta would produce at once more cordial relations between this country and Spain, for both countries would benefit considerably by such an arrangement.

(*c.*) Ceuta from its situation would, as regards provisions in time of war, be practically self-supporting.

(*d.*) A good safe protected Naval and Mercantile harbour of great area can be easily constructed at Ceuta, one practically secure from any serious bombardment.

(*e.*) And in time of peace such a port as Ceuta, in British hands, would certainly become the Emporium for trade of Morocco and North-Western Africa, and, as such, of incalculable commercial value to this country. It would, in addition, give to England a far firmer hand in the manipulation of the dangerous question of our relations with the Continental Powers, and more especially so those of France with Morocco.

England seems now verging on a time of trouble and anxiety; surrounded by great possible dangers, rendered more difficult in that the Gracious Directing Hand which so long helped to guide and direct the helm of State has—crowned with the affections and love of her people—alas! departed from us. The binding together into one whole of the Old Country and her great Colonies, the new developments in Trade, the spread of Education, the enormous strides made in Science and the urgent demands of new methods to meet all these altered circumstances, necessitate a most watchful care in the fostering of any possible developments, which may offer any successful openings up of new fields of legitimate trade and industry.

Morocco is a country, which from its position, and the unrivalled possibilities it offers in climate and natural sources of wealth, must sooner or later rivet the attention of all those desiring to share such undoubted advantages.

Morocco strong and independent under firm rule, and able to hold her own with an "open door" to all for trade, would be a source of safety and profit to all those nations who chose to benefit by it. Should we allow her to lapse into anarchy, or to become the prey of any one Power, it would be destructive to our greatest interests. On no account could we possibly permit the Northern Moroccan shores bordering on our great highway in the Straits, to fall into the hands of any Power who could use them inimically to ourselves. It is only at Ceuta that we can secure a prosperous future for the Moorish Empire, and with it our trade in the Mediterranean, the safety and integrity of our possessions in the East, and our naval supremacy in the Great Inland Sea.

Very recently we have had the unique experience of a visit by the Heir to the Throne, to all the outlying portions of Greater Britain which go to form a vast Empire which, tried in the fire by a great war, has under Providence been welded into one homogeneous whole, such as the world has never before realised or even dreamt of. The finding of that wise Prince as to our requirements, in view of the general race for advancement, amongst the great nations of the world, has been summed up in two simple but pregnant words, so far-sighted, true, and comprehensive, that I cannot do better, so apposite do they seem to the present question, than quote them here, for if England is to hold her own in the coming struggle of Nations, she must indeed "Wake Up."

APPENDIX.

GIBRALTAR.

"Mons Calpe" of the Ancients, one of the "Pillars of Hercules," "The Column of the Inner Sea." Ptolemy.

711. Not inhabited till Mohammadan Invasion under Tarik. Gebal-Tarik—the mountain of Tarik.

1086. In possession of Yussef ben Taxfin, a Calif of Almorarides.

1309. First Siege.—Ferdinand IV.'s General Alonzo Pereydel Gusman took it.

1315. Second Siege.—By Ismail ben Ferag; unsuccessful.

1333. Third Siege.—By Mohammed IV.; successful.
Fourth Siege.—By Alfonso; unsuccessful.

1349
1350 Fifth Siege.—By Alfonso; it was unsuccessful, and Alfonso died during the siege. The Moors from the Rock attended his funeral unarmed, as a chivalrous mark of respect.

1411. Sixth Siege.—Taken by African Moors from Yussef.

1436. Seventh Siege.—Gusman the Good, drowned.

1462. Eighth Siege.—Successfully regained by Spanish.

1466
1467 Ninth Siege.—Civil War—Duke of Medina Sidonia took it after 15 months' siege.

1502. Reverted to Ferdinand and Isabella.

1506. Tenth Siege.—Duke of Medina Sidonia unsuccessful.

1540. Turkish pirates from Algiers raided City, but failed to take fortress; they landed at Europa point.

1558. Again attempted by pirates; unsuccessful.

1693. Bombarded by French Fleet under de Tourville.

1701. War of Spanish succession.

1704. July 21st. Sir G. Rooke with 45 line of battle ships anchored in Bay. Landed 2,000 men under Prince of Hesse on Isthmus on west front. Spanish garrison of 500 unprepared. July 22nd, bombarded with fleet. July 24th, surrendered to Britain.

1704
1705 Twelfth Siege.—By French and Spanish; unsuccessful.

1715
1726 Negociations were several times almost completed for its retrocession to Spain.

1727. Thirteenth Siege.

1779
1783 Fourteenth Siege.—June 21st to March 12th. Defended successfully by General Eliott with 5,382 officers and men, against French and Spanish fleets and armies.

CEUTA.

Called *Cibta* or *Sibta*. Portuguese, *Seupta*; Spanish, *Thaota*, spelt *Ceuta*. Held by Carthaginians in the first place. Then as a Roman colony *Exclissa*.

534. Justinian restores its forts.

618. Ceuta taken by Goths under Genseric.

741. Seized by Syrians fleeing from revolted Berbers. Town built by Mujakis, called "Muja Kissa." (Contemporary, Anglo-Saxon Heptarchy.)

710. Under Julian the Christian. Under Tarif 100 horse and 100 foot invade Visigoth Spain. Ceuta given over to the Moors.

931. Ceuta captured by Abd' er Rahman of Cordova.

1077. Ceuta attacked by Yusef I.; holds out several years.

1083. Ceuta taken by Marabtis, under Yusef. (Contemporary, 17 years after the conquest of England by William; 16 years before the Crusaders in Jerusalem.)

1148. Walls of Ceuta raised by Abd' el Mumin, the builder of the town of Gibraltar and Castle named Gibraltar. (Jebel el Fatah, Mount of Victory.)

1172. Arsenal built.

1242. Khalifat of Tunis proclaimed and acknowledged.

1269. Ceuta capital of the Riff and independent. Skilled in brass work. Trade with Genoese in gold, ivory, and slaves.

1274. Yakub II. and Iago I. of Arragon agree to attack Ceuta.

1303. Ceuta captured by Ameer of Grenada.

1307. Suleiman I. (Abu Rabia) captured Ceuta, with assistance of Iago II. of Arragon, from the Ameer of Grenada, it passes finally to the Beni Morin.

1359. At Abu Aiman's death, Abu Salem, with aid of Rifis, seizes Ceuta and Tangier.

1386. Ceuta taken from Grenada (Ahmad II.)

1415. Ceuta captured by Portuguese under Joao I., with fleet commanded by Prince Henry III. of Spain, carrying 30.000 soldiers in 20 pinnaces, 33 galleys, and 27 triremes.

1418. Besieged by 100,000 Moors, supported by troops from Tunis and Grenada—ineffectively. (Contemporary, Henry V., Battle of Agincourt.)

1432. Moorish mosque made into a Roman Catholic cathedral—maintained by indulgences to Spain by Papal Bull called the "Milk Bull."

1458. Ceuta in possession of the Portuguese.

1497. Spaniards in Melilla, Ceuta, &c. (Contemporary, Columbus landed in America.)

1578. Seized by the Spaniards. (Contemporary, Camoens died at Macao China.)

1579. Portuguese possessions seized by Spain. (Contemporary, 1572, Massacre of St. Bartholemew.)

1660. Charles II., English in Tangier abandoned 1684. (Contemporary, Peter the Great, 1682.)

1642. Portuguese in Tangier. (Contemporary, 1642, deaths of Richelieu and Gallileo, Commonwealth, 1649.)

1662. English in possession of Tangier. (Contemporary Charles II., 1660.)

1694 } 1720 } Besieged by Ismail for 26 years until Felipe V. raised it. Camp still visible on road to Tangier. (Contemporary, 1588, Spanish Armada defeated.)

1732. Besieged unsuccessfully by Abd' Allah. Portuguese chronicler Azurara declares: "Of a surety no one can deny that Ceuta is the very key of the Mediterranean Sea."

1704. Gibraltar captured by the English under Rooke. (Contemporary, Battle of Blenheim, 1702.)

1810. Ceuta occupied a short time, under Fraser, by the English. (Contemporary, 1814, abdication of Napoleon.)

TABLE I.—Gross Amount of Various Branches of Revenue and Expenditure at Gibraltar for Year 1899.

Branch of Revenue.	Gross Amount.	Branch of Expenditure.	Gross Amount.
	£		£
Duties on Wines	3,139	Governor	4,361
,, Spirits	5,905	Colonial Secretary	2,654
,, Malt Liquors	1,497	Treasury and Audit	3,303
,, Tobacco	7,703	Port Department	4,134
Port and Quarantine Dues	6,179	Administration of Justice	4,828
Licenses, Liquor	3,099	Police and Gaols	6,690
,, other	954	Ecclesiastical Grants	934
Rent for Market Stalls	1,875	Education	1,538
Revenue Stamps	777	Medical and Hospitals	4,707
Store Rents (Wines, &c.)	431	Lunatic Asylums	1,442
Ground Rents	5,165	Supervision of Markets	996
Other Rents	977	Colonial Engineer	763
Forfeitures and Fines in Court	234	Public Works	5,549
Cemetery, &c.	1,735	Post and Telegraph	6,257
Fees of Office	1,634	Register of Births	240
Post Office	8,584	Pensions	1,966
Telegraph	607	Stationery and Printing	1,230
Interest on Investments	375	Electric Light	4,639
Electric Light	3,000	Loan on Exchange	145
Savings Banks	4,464	Colonial Government Assets	504
Reimbursements in aid	332	Charges for Debt	714
Miscellaneous	1,288	Miscellaneous	1,927
Total	£59,945	Total	£59,521
Loan from Savings Bank Fund	£3,096	Expenditure from Loan	£3,096

TABLE II.—Estimated Cost of Military Establishment (Average) at Gibraltar.

General Staff Regimental Pay and Allowances	£116,910
Divine Service	1,522
Martial Law	997
Army Medical	6,566
Army Reserve Pay Debt	25
Commissariat and Ordnance	16,450
Provisions, light, forage, fuel and transport	93,634
Clothing	372
Stores, washing and bedding	1,102
Civil Engineer Department	2,024
Works Department	25,482
Military Education	532
Miscellaneous Services	106
Non-effective ,,	3,215
Repayment ,,	2,259
Total	£271,196

TABLE III.—Amount of Exports and Imports at Tangier, Fez, Tetuan, and Laraiche, for Years 1897, 1898.

Country.	Tangier.				Fez.		Tetuan.				Laraiche.			
	Exports.		Imports.		Exports.	Imports	Exports.		Imports.		Exports.		Imports.	
	1898.	1897.	1898.	1897.	1897–8.	1897–8.	1898.	1897.	1898.	1897.	1898.	1897.	1898.	1897.
	£	£	£	£			£	£	£	£	£	£	£	£
Great Britain...	76,156	66,459	175,281	165,873	No returns.	No returns.	...	...	...	...	13,774	15,305	103,670	124,107
France	23,280	20,724	54,792	87,195			...	...	...	...	41,734	21,882	50,711	63,614
Spain	67,947	39,920	16,448	8,540			133	60	435	156	1,262	837	142	...
Germany... ...	5,637	8,044	37,816	41,398			...	...	...	...	7,674	1,288	2,220	6,384
Egypt & Tripoli	49,523	46,709	...	...			...	...	...	...	...	...	...	...
Italy	5,862	6,036	2,040	772			...	...	...	...	...	...	830	809
Belgium	...	...	7,430	...			...	...	...	...	127	211	7,115	11,690
Holland	...	293	1,841	2,388			...	...	...	...	...	...	...	...
Sweden	...	...	2,330	...			...	...	...	...	...	...	...	...
Denmark... ...	...	...	...	...			...	...	...	...	...	...	...	...
Portugal	...	...	...	...			...	...	...	...	...	...	...	...
Gibraltar... ...	...	...	...	...			5,208	4,782	30,775	33,067	2,159	1,643	4	4
Norway	...	...	...	...			...	...	...	...	...	...	...	...
Oran...	...	...	...	...			60	120	...	93	...	...	...	...
Total ...	228,405	188,185	297,978	306,166	...	...	5,401	4,962	31,210	33,316	66,730	41,166	164,088	206,604
	1900.	1899.	1900.	1899.			1900.	1899.	1900.	1899.	1900.	1899.	1900.	1899.
Totals for years 1899 and 1900...	£ 386,274	£ 261,478	£ 488,674	£ 427,748	No return.		£ 4,360	£ 6,348	£ 33,586	£ 40,614	£ 47,032	£ 62,675	£ 114,093	£ 202,278

TABLE IV.—Numbers and Tonnage of British and Foreign Vessels Entered and Cleared Gibraltar—Years 1897, 1898, 1899.

	1897		1898		1899	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
Entered—						
British	2,786	3,331,297	2,878	3,574,819	2,439	3,241,492
Foreign	1,507	1,039,829	1,350	989,003	1,516	1,087,367
Total	4,293	4,371,126	4,228	4,563,822	3,955	4,328,859
Cleared—						
British	2,770	3,323,416	2,851	3,567,842	2,413	3,224,798
Foreign	1,415	1,025,627	1,304	982,726	1,437	1,074,880
Total	4,185	4,349,043	4,155	4,550,568	3,850	4,299,678

TABLE V.—AREA AND TOTAL POPULATION (GIBRALTAR).

Area.	Date.	Population.					
		Civil.			Military.	Aliens and Resident Strangers.	TOTAL.
		Males.	Females.	Total.			
Sq. Miles. 1⅞ Miles	April 3, 1881. April 5, 1891.	7,762 7,736	7,887 9,170	15,649 16,906	5 610 5,896	2,732 2,194	23,901 24,996

TABLE VI.—GROSS AMOUNT OF PUBLIC REVENUE AND EXPENDITURE (GIBRALTAR).

	For Years:		
	1899	1898	1897
	£	£	£
Revenue	59.954	56,019	49,928
Expenditure	59,521	48,878	46,272

TABLE VII.—NUMBER AND TONNAGE OF SHIPS AND STEAMERS "ENTERED" AT TANGIER, LARAICHE, AND TETUAN, FOR YEARS 1898 AND 1900.

Nationality.	Tangier, 1898.						Laraiche, 1898.						Tetuan, 1898.					
	Sailing.		Steam.		Total.		Sailing.		Steam.		Total.		Sailing.		Steam.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.	Vessels	Tons.	Vessels.	Tons.	Vessels	Tons.	Vessels.	Tons.
British	2	50	303	129,144	305	129,124	5	213	43	22,228	48	22,441	41	506	41	4,521	82	5,027
French	1	683	79	48,609	...	...	...	...	30	15,978	30	15,978	...	...	1	140	1	140
German	...	...	38	34,500	38	34,400	...	...	23	16,661	23	16,661	1	146		. .	1	146
Spanish	231	4,804	324	118,228	555	123,032	12	230	11	5,622	23	5,852	37	502	1	93	38	595
Portuguese ...	12	359	...	...	...	...	13	711	...	...	13	711	...	...	—	. .		
Danish	...	...	1	686	1	686	1	126	1	686	2	812	...	...	...	.	...	...
Netherlands ...	...	...	11	8,850	11	8,850	3	384	...	...	3	384	...	...	...	...	...	...
Norwegian ...	...	...	2	721	2	721	2	134	...	...	2	134	...	...	...			. .
Italian	...	...	22	43,000	22	43,000	...	...	...	...	...	...	...	...	...	...	...	...
Austro-Hungarian ...	...	...	1	1,381	1	1,381	...	...	...	...	...	...	...	...	...	...	..	...
Russian	1	193	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Totals ...	247	6,089	781	385,428	1028	391,517	36	1,798	108	61,175	144	62,973	70	1,154	43	4,754	122	5,908
Total for year 1900... ...	343	11,288	774	412,629	1336	423,917	96	3,590	69	41,738	165	45,337	68	990	59	27,303	127	28,293

TABLE VIII.—TOTAL EXPORTS AND IMPORTS OF TANGIER, TETUAN, AND LARAICHE, FOR YEARS 1897-1898.

Seaport Towns.	Total Exports.		Total Imports.	
	1898.	1897.	1898.	1897.
	£	£	£	£
Tangier............	228,405	188,185	297,978	306,166
Tetuan	5,401	4.962	31,210	33,067
Laraiche	164,668	66,730	231,418	247,871
Total	398,474	259,877	560,606	587,104

Total exports and imports for three ports—1898, £959,080; 1897, £846,981.

Remarks.

The Vice-Consul MacLeod at Fez gives no return of trade for 1898—refers to former Reports.

Mr. Consul White's return for Tangier is complete and exhaustive, regrets that England does not compete with Germany in fine cheap cloth.

The trade at Alcazar is briefly put down at £30,000, for calico goods English.

Mr. Consul Forde's Report of Laraiche is most excellent.

TABLE IX.—Gibraltar under Naval Works Act.

Statement showing the aggregate amount of money expended for any purpose of the Naval Works Acts of 1895, 1896, 1897, and 1899, the purposes on which that money has been expended, and the balance (if any) of the sums authorised to be issued for any such purpose.

Works.	Total Estimated Cost.	Actual Expenditure.					Amounts authorised to be expended out of the Funds provided by the Naval Works Acts, 1895, 1896, 1897, and 1899, as revised by the Act of 1899 (for details see explanatory Statement A. attached).	Expenditure charged against the Amounts authorised (As per Column 6.)	Balance.		Works.
		Charged against Naval Vote.	Charged against Funds provided by the Naval Works Act, 1895, 1896, 1807, and 1899.			Aggregate Expenditure to 31st March, 1901. Total of Columns 3 and 6.			Amounts authorised in excess of Expenditure.	Expenditure in excess of Amounts authorised.	
		Period prior to inclusion in the Services provided for by the Naval Works Act.	Period 1st April, 1895, to 31st March, 1900.	In the Year ended 31st March, 1901.	Total of Columns 4 and 5.						
1.	2.	3.	4.	5.	6.	7.	8.	9.	10	11.	12.
	£	£ s. d.	£ s. d.	£ s. d.	£ s d	£ s. d.	£	£ s. d	£ s. d	£ s. d.	
(a) Enclosure and Defence of Harbours:											(a) Enclosure and Defence of Harbours:
Gibraltar	1,026,000	24,148 0 4	741,392 19 0	179,542 11 1	920,935 10 1	945,083 10 5	888,046	920,935 10 1	...	32,889 10 1	Gibraltar.
Gibraltar, Commercial Mole.	669,000	...	65,733 14 4	73,826 10 10	139,560 5 2	139 560 5 2	128,481	139,560 5 2	...	11,079 5 2	Gibraltar Commercial Mole.
(b) Gibraltar Dockyard Extension (including £63,000 for Fixed Machinery).	2,674,000	3,779 4 3	387,028 9 11	211,318 9 1	598,346 19 0	602,126 3 3	514,720	598,346 19 0	...	83,626 19 0	(b) Gibraltar Dockyard Extension (including £63 000 for Fixed Machinery).

A.—Explanatory Statement showing what portions of the estimated expenditure set out in the Naval Works Act, 1899, were intended to be met respectively out of Naval Votes, and the fund provided by that Act and the previous Naval Works Acts of 1895, 1896, and 1897.

Works.	Estimated expenditure to March 31, 1899, per total of cols. 3 and 4 of the Naval Works Act, 1899.	Deduct: expenditure estimated to be met out of Naval Votes prior to inclusion in Naval Works Acts.	Net expenditure to 31st March, 1899, Estimated to be met out of the funds provided by the Naval Works Acts, 1895, 1896, and 1897.	Estimated expenditure for the years 1899-1900, and 1900-1901 as per col. 5 of the Naval Works Act, 1899.	Total expenditure authorised by the Naval Works Act, 1899, to be met out of the funds provided by the Acts of 1895, 1896, 1897, and 1899.
	£	£	£	£	£
(a) Enclosure and defence of harbours:					
Gibraltar...	562,194	24,148	538,046	350,000	888,046
Gibraltar Commercial Mole ...	8,481	...	8,481	120,000	128,481
(b) Needs of Fleet:					
Gibraltar Dockyard extension...	318,499	3,779	314,720	200,000	514,720

Statement showing the Actual Expenditure in the Financial Year 1900-1901 as compared with the amount which remained available on 1st April, 1900 (*vide* Columns 10 and 11, page 5, Naval Works Account 1899-1900).

1900-1901.—Account of the Sums Expended, compared with the Sums Available for any purpose of the Naval Works Act of 1895, 1896, 1897, and 1899 in the Year ended 31st March, 1901, showing the Surplus or Deficit upon each Item of the Account.

Item.	Amount Available on 1st April, 1900	Actual Expenditure during Period 1st April, 1900, to 31st March, 1901.	Actual Expenditure compared with Amount available.		Explanation of the Causes of Variation between Actual Expenditure and Amount Available.
			Less than Amount Available.	More than Amount Available.	
	(1.)	(2.)	(3.)	(4.)	
	£ s. d.	£ s. d.	£ s. d	£ s. d.	
(a) Enclosure and Defence of Harbours: Gibraltar	146,653 1 0	179,542 11 1	...	32,889 10 1	These two works have advanced more than was expected.
,, Commercial Mole	62,747 5 8	73,826 10 10	...	11,079 5 2	
(b) Gibraltar Dockyard Extension	127,691 10 1	211,318 9 1	...	83,628 19 0	Increased expenditure chiefly due to the progress on No. 3 Dock and the Machinery Shops.

TABLE X.—HEADS OF PROPOSED EXPENDITURE.

Works. 1.	Total estimated cost, 1901. 2.	Expenditure to 31st March, 1900. 3.	Estimated expenditure from 1st April, 1900, to 31st March, 1901. 4.	Estimated expenditure for the financial years 1901-1902 and 1902-1903. 5.	Expected date of completion. 6.
(*a*) Enclosure and defence of harbours.	£	£	£	£	
Gibraltar	1,239,000	765,541	179,843	213,000	1902-3
Gibraltar, Commercial Mole	*669,000	63,734	73,954	300,000	1903-4
Gibraltar, Dockyard extension	2,674,000	390,808	198,584	470,000	1904-5

* The total estimated cost of the Commercial Mole is £700,000, including £31,000 for superintendence under item (*d*). Four-sevenths of this sum is to be repaid by the Colony of Gibraltar in the form of an annuity of £14,000 per annum for 57 years from the opening of the Mole, to be credited as an appropriation in aid of Navy Vote 10.

DISCUSSION.

Major-General STERLING said the paper went over ground which had become somewhat familiar during the past half-century. He heard the discussion on the subject started more than 40 years ago, and went to the Mediterranean in order to obtain more information. While having no wish to controvert any statement of fact made by the reader of the paper, his statements of theory were open to some controversy. It had long been discussed whether an eastern harbour was practicably feasible, as it would be open to the Levanters on the east side sending big rollers from the whole length of the Mediterranean. The general opinion had been that the breakwater would share the same fate as the Alderney breakwater, and that the expenses of dredging and keeping it open would be portentous. Under any circumstances, the fact must be faced that England was a nation containing between 36 to 38 millions of people, and that it could not hold every place on God's earth, which might be useful to their individual idiosyncracies. The land forces of the country were plunged up to the hilt in the work which they could be called upon to do, and the nation must depend, in the first place, on its island position and its naval forces. The reader of the paper had stated that in peace time the western harbour of Gibraltar was of supreme value; he would further add that even up to the very minute before the outbreak of war, the value of the breakwater in enabling our ships to go out properly coaled, properly cleaned, and ready to fight, was of great value to the potential fighting power of the nation. He was not prepared to say that under certain circumstances, guns might not be mounted in Spain which could command a portion of the Rock, but he would like to ask whether since the American War, the power of Spain had been so much increased, that there was an increasing danger to England. In addition, was the condition of France so excessively thriving? Had they no difficulties of their own, that they were going to march an army down and set up another Spanish ulcer, and launch arms and forces against our position at Gibraltar? He thought the reader of the paper had over-stated the points against England, and had understated the difficulties a possible enemy might have. In connection with the European and African question, he also thought the author had very much worsened the position that the French would have if England was again committed to a large hold on the Morocco territory, a position on his own showing open to attack from the whole of the Oran frontier, most of which he had carefully studied. He thought General Crease had underrated the antagonism which it would create in France if England took Ceuta instead of Gibraltar, in addition to which a breakwater costing untold millions would have to be built, and 6,000 yards of very difficult frontier defended, which it would take at least an army corps of 30,000 men to hold. If difficulties did arise between Spain and England there was a very much better place than Ceuta which would tumble into our hands as sure as death and taxes.

Colonel JOHN DAVIS said that, although he had not the advantage possessed by General Sterling of having been over the ground, he was inclined to agree, in a very great measure, in the conclusions arrived at by Major-General Crease. The arguments in the paper seemed to be very strong indeed. Naturally, the great difficulty of the whole question was the political position. The subject was a very great national question. The only thing which could be done was, first of all, to educate the people of the country on the subject, up to the stage of knowledge possessed by Major-General Crease. When that was done he believed it would be considered by most people who took Major-General Crease's view, that Gibraltar would not be as strong in England's hands as Ceuta. What General Sterling had said in relation to the long frontiers which would have to be defended, was very true, but he believed there were very strong natural positions which could be fortified and made almost impregnable.

The CHAIRMAN, in proposing a vote of thanks to Major-General Crease, said the paper must have involved an enormous amount of labour, and it showed a very long and well thought out acquaintance with the subject by the reader of the paper. Personally, he intended to exercise the wise discretion of saying nothing on the subject. He felt that Gibraltar must be spoken of with bated breath, and that it was impossible to conceive it was in any kind of danger.

The resolution was carried unanimously.

Major-General CREASE, in reply, after thanking the members for the resolution they had passed, said that with reference to the remarks made by Major-General Sterling it must be understood that the question was as much a naval as a military one. It was that fact which induced him to take it up, because he found that the military authorities, when naval men reported to them, said they knew nothing at all about military subjects, and the naval authorities, when military men reported to them, said they knew nothing about naval subjects. That could not be said of him, because he was both naval and military. He considered that Major-General Sterling's statement that the breakwater would cost countless millions was overdrawn. He thought the Chairman could tell them that it would not cost more than 1½ millions, and certainly not more than two, which was not a very large sum nowadays. With respect to the frontier, the reason that Ceuta was so valuable compared with Gibraltar was that it had outside it a fine, strong, open defensive position and ground which would supply the troops with food. The number of troops necessary to occupy that position would not exceed a garrison of more than 3,000 men. Ceuta could not be attacked anywhere from the mountains or from the plain with any chances of success because if batteries were established there they must be seen into by the ships in the rear, and no batteries, attacking a fort like Ceuta, could exist under such conditions. Therefore Ceuta exactly provided what they would be all the better for having if it could be obtained at Gibraltar. The fault at Gibraltar was that the heights outside did not belong to England. If the outside belonged to England she would be stronger at Gibraltar than she was at the present time. He thought most military and all naval men would agree with him in the conclusions he had come to. It was not the impregnability of Gibraltar which England had to care about, but the use of that impregnability. What was the use of the impregnability if it did not give a harbour in which British ships could coal and refit? It was of no use at all. Therefore any impregnability which Gibraltar had was a snare and a delusion. Gibraltar was no more impregnable than Portsmouth, having been besieged thirteen times, on seven of which it had been captured.

Miscellaneous.

DR. WILLIAM GILBERT'S AUTOGRAPH.

The following account of the recent discovery of two autographs of William Gilbert, are taken from an article by Dr. Silvanus P. Thompson, F.R.S., in the *Electrician*:—

Until quite recently, not one example of the handwriting of the father of the science of electricity, Dr. William Gilbert, was known to exist. The manuscript of his famous "De Magnete," printed in 1600, has long ago perished. All his own collection of manuscripts, maps, minerals and magnets, together with his correspondence with the learned men of Europe, was burned in the great fire of 1666. The very spelling of his name was a matter of dispute and conjecture, for while many wrote it Gilberd, others spelled it Gilbert. It was printed as Gilbert in his own lifetime in Blundevile's "Theoriques of the Seven Planets," in 1602. Two at least of the copies now extant of "De Magnete" are presentation copies and bear inscriptions on the title page. That in the library of the Royal Institution has the words, *Ex dono auctoris*, while that in the possession of Mr. C. L. Clarke, of New York, bears the record *Dedit Guil: Gilbertus. Jo: Sherwood propriis manibus.* The latter is certainly not, and the former probably not, in Gilbert's handwriting, though both have been conjectured to be his. The doubt has been set at rest by two discoveries.

The first of these is a medical certificate preserved in His Majesty's Record Office in London amongst the State Papers. It runs thus:—

To the Right honourable Sir Francis Walsingham,
Knight, Principal Secretary to her Maiesty.

Pleaseth it yo^{r} Honno^{r} to be advertised That whereas wee are required by this Gent. Mr. Hungait, to delyver our opinions as concerning the cause of his desire to travyll beyonde the seas, True it is that we have advised him thereunto as thinkinge his being for some tyme in hotte and drye Countryes will muche staye the wayt and fflux of his cold and Rhumatike diseases, which by longe observation, both he and wee have founde, to abounde most when the weather is Colde and Intemperate, And thus most humblye taking our leaves we cōmit yo^{r} Honno^{r} to the benediction of the Almightie, London this first of Februarye 1584.

Yo^{r} Honnor^{s} most
redely to comaunde

WILLM GYLBERDE.

LANCELOT BROWNE.

Gilbert at that date was not yet appointed physician to Queen Elizabeth, nor President of the Royal College of Physicians. The Lancelot Browne who also signed the certificate, succeeded Gilbert in the latter office in 1603.

The second discovery has been made by Mr. R. F, Scott, Senior Bursar of St. John's College, Cambridge, which office was held by Gilbert himself in 1570. The books of St. John's College contain one or two entries in his hand on his admission to a Fellowship and some college offices. Here he signs his name as Gylberd.

I have also searched Somerset House for the signature to his will, which was supposed to be an original document. It proves, however, to be only a copy, and in it the name is spelled both Gilberd and Gilbert.

As Gilbert had correspondence with Sarpi and Sagredo and other learned men on the Continent of Europe, it is probable that letters of his may exist in the libraries of Continental universities. Enquiries lasting over 15 years have, however, failed to elicit any evidence of their existence.

POULTRY CULTURE IN FRANCE.

In the last report of Consul-General Inglis, of Paris, an interesting account is given of the method adopted in France in poultry culture, and a description of the artificial incubation which has for many years past been conducted on a large scale, particularly at Gambais, near Houdan, on the Paris-Granville line, about 31 miles from the capital. At this place there is a practical school of aviculture, which was instituted in 1883 by a decree of the Minister of Agriculture, and it is in the centre of the poultry farming industry, Houdan itself being renowned for its breed of fowls, the favourite description being Houdans, Crèvecœur, La Fléche, and Faverolles. The Bresse, another breed—a cross between the Andalusian and common fowl—is bred extensively about Bourg, and gives the renowned "Poularde de Bresse." The School of Aviculture at Gambais enjoys a high reputation, and pupils of either sex are received. Candidates must not be under the age of 15, and must have received a certain amount of general instruction, such as would entitle them to a certificate from the primary schools. The terms are £14 for a three months' course, including tuition, board, and lodging. On leaving the school, pupils who have shown capacity to act as instructors in aviculture, receive a certificate of competency, which, it is said, enables them without difficulty to obtain employment in this line of industry. In connection with the system of artificial incubation which is practised at the school, it may be said that the incubators and other appliances are more or less the invention of the original founders. Heat, moisture, and aëration are the principal factors in the process of incubation. The heat is now arranged so as to come from above, and, being thus directed on the entire surface of the drawers in which the eggs are arranged, is more evenly distributed, and it is claimed that the eggs, by receiving the warmth from above, are in this respect in the same condition as if under the hen. Regular aëration is obtained by pipes running along each side of the apparatus, and an outlet at the same time secured for the carbonic acid disengaged by the embryos. The requisite degree of moisture is ensured by taking advantage of the difference between the temperature of the drawers and that of the surrounding atmosphere, the two currents being brought into contact by the lateral pipes already referred to; a moist vapour is the result, similar to that observable on the windows of a room in winter. The new hydro incubator used is capable of accommodating from 200 to 500 eggs, the price of the apparatus ranging from £6 to £12, the latter including drying-box. Heating is now effected by a small briquette of compressed brick dust, which burns slowly from 12 to 14 hours, according to dimensions. To heat an incubator of 250 eggs it is said that three-fourths of a briquette, costing 1½d. is sufficient for 12 hours. The danger of fire inseparable from the use of a lamp is thus eliminated, since the briquette is placed out of harm's way in a specially-arranged chamber. An incubator of 60 eggs requires about 20 briquettes, one of 130 eggs 25, of 250 eggs say 35. The eggs having been placed in the incubator in the morning, the drawers are not opened until the evening, and then only for three or four minutes; the next morning the temperature is taken, the drawers are removed, and the door is then closed; the eggs are turned over and their places changed, so that the eggs which were in the centre are now at the sides of the drawers; they are thus made to occupy alternately the warmer and cooler parts of the apparatus, and are never twice in succession in the same place nor on the same side. An ingenious contrivance has been devised for effecting this operation, which, however, does not appear to require any great expenditure of time, as it is said that as many as 200 eggs can be turned in five minutes, or in ten minutes by an inexperienced hand. After the lapse of ten more minutes the eggs are returned to their places, having been out a sufficient time, if it is summer, for aëration and cooling; the water is then re-heated, or the briquette replaced in the apparatus, the whole then remains undisturbed until 7 p.m.; the doors are, however, opened at 1.30 p.m., and the eggs are gently fanned so as to renovate the air, thus also imitating the hen flapping her wings; at 7 p.m. the temperature is taken, to see if any water has to be drawn off and replaced by a further supply. The eggs are then once more turned and their places changed, as in the morning, and the whole is at once closed. Such is the procedure during the whole period of incubation. To recapitulate:—(1) Temperature 39° to 40° (Centigrade) during the course of incubation; (2) rearrangement of the eggs, as described morning and evening; (3) maintenance of the temperature by the addition of boiling water, or of the briquette, and (4) testing the eggs. With regard to the last item, it is estimated that in dealing with a large number of eggs, some 20 to 50 per cent. are sterile, hence the necessity of testing. This is done on the fifth day (120 hours), a special lamp tester being employed for that purpose, or the operation must be performed in a darkened room. In this case, the light is placed at a height of about five feet, the egg being held with the fingers of the right hand, the large end uppermost, while the left placed over the egg, acts as a shade. A practised eye can then readily distinguish the fertile egg. After 120 hours in the incubator, if fertile, the yoke is seen to be dilated, forming a semi-circle shaded at the base. The embryo is seen in the centre, and resembles somewhat a spider, the legs of which are represented by the blood vessels, now plainly apparent in proximity to the embryo, and increasing in distinctness as they approach the perimeter of the egg. If the embryo is alive, it oscillates from right to left, from the bottom upwards, every time the egg is moved. If on the other hand it is without life, the vessels are dull and ill-defined, and the embryo will be seen clinging to the sides, and remain motionless, having the appearance of a spot of ink. Before being placed in the incubator, eggs are also tested as to freshness. The air chamber is barely visible on the first day, but goes on increasing in dimensions. Eggs should not be more than a week old. They are collected in boxes with partitions, so that each egg is in a separate compartment and cannot receive a shock or get cracked. They are then placed in a box and covered with bran or dry sawdust. Shaking caused by conveyance in carts or by railway is prejudicial; it cannot, however, always be avoided, and in these cases the eggs are laid on grain, in a cool, dry place, for 24 to 36 hours. Fertile eggs cannot be recognised until after five days incubation. The 21st day having been reached, the drawers of the incubator are opened at 7 a.m., and the temperature noted as usual; the chirping of the young brood will now probably be audible. Eggs not hatched out are, however, turned as usual, any shells showing signs of perforation being placed with the perforated side uppermost, so that the young chickens may more readily breathe. Chickens already hatched out are now transferred to the drying box. At noon the incubator is again opened, and the operation proceeded with as before, the chickens being covered with a soft woollen cloth in summer, and with a small eider down in winter; the more numerous the brood the less susceptible will they be to cold. The young birds are never helped out of the eggs, except, perhaps, when it adheres only by a few strands of membranes. If the chicken is assisted to emerge from the shell, there is every danger of the blood vessels being lacerated, and the loss of a single drop of blood at this stage is, it is said, sufficient to cause the death of the chicken in three to four days. The drying-box is prepared with a layer of soft straw or hay, barley straw being preferred; 40 to 50 chickens are placed in it and covered, as already described. The next day they are brought out into the open compartment; but at this stage no food is given. After being out from five to ten minutes they are restored to the box, to be taken out again two hours later. This time they are given a few crumbs of very dry bread. After a day in the drying-box, they are transferred to the artificial mother or breeder; two of these suffice for some 450 chickens. During the first week they receive constant attention; on the third or fourth day they are given some liberty, being let out into an enclosed space a few yards square, but the moment they show signs of chilliness they are driven back under the protection of the breeder. The food during this early period consists of a paste made of barley-meal and milk, sufficiently consistent to adhere to the wooden billet employed for that purpose. Instead of waiting, as is usual in the Bresse and Maine, until the birds are six to eight months old, at Gambais the operation of fattening for the table begins as soon as the pullets have reached the age of three and a-half months. Cages containing fifty birds are arranged along the walls of the building devoted to this purpose, which is kept warm in winter, and, as as far as possible, cool in summer. The floor of these cages is covered with a thick layer of straw, which is renewed every morning. Three meals are given every day for a fortnight. The first consists of a lukewarm liquid mash, composed of barley meal and water; the second is the same; but for the third, the mash is made with milk or "petit lait." The latter is the milk running from cheese in process of manufacture, and fetched in barrels from the manufactories. At the end of a fortnight, the fat begins to make its appearance. In order to give the finishing touch, a small quantity of lard is now given to each bird at each meal. This is continued for four or five days, when the bird will be so fat that, if the *regime* were maintained for two days more, it would inevitably succumb. If it is sought to attain the extreme limit of perfection, for the last three days eggs are added to the mash in sufficient quantity for each bird to have at least one per day. The food is given by means of a funnel specially made for the purpose. Two persons, it is said, can thus dispose of sixty fowls in an hour, or one a minute.

THE HAT INDUSTRY IN ITALY.

The provincial town of Monza was the ancient capital of Lombardy; it is now chiefly remarkable for its manufacture of hats and caps. Statistics show that in the year 1818 the town possessed 37 hat factories, which gave employment to 286 workmen. In 1850, the number of factories had only increased to 40 and the hands engaged to about 300. In recent years, however, the most important firms have introduced machinery into their establishments, which has not only resulted in greater precision and finer finish, but has notably increased the output. The cost of production has also been considerably diminished, due in a great measure to the utilisation of waste wool. This waste wool is imported from France—from such centres as Turcoing, Roubaix and Fourmiens—and finds a good market in Italy. Monza produces very few silk hats, these being made in small quantities by hand at Milan and Alessandria. The articles are manufactured almost exclusively of fur or wool. Information is not available as to the precise number of hats and caps turned out annually; but the six better-equipped establishments are probably capable of producing from 60,000 to 70,000 a day. These concerns use the most improved machinery, and employ about 4,000 hands. Monza is not successfully competing in the hat industry with the rest of Italy, but has become a formidable rival to similar manufacturing centres throughout Europe. Her products are exported to Central and South America and to some European markets, principally Roumania and the Balkans, where woollen hats are in demand.

DUBLIN ART EXHIBITION.

The Royal Dublin Society has issued the list of the prizes, amounting to upwards of £200, which will be offered in competition at the Art Industries Exhibition to be held on the Society's premises, Ball's-bridge, Dublin, in conjunction with the great Irish Horse Show in August next. The prizes will be offered in the various sections of the Exhibition as follows:—Lace embroidery and designs, £110; wood carving, £50 10s.: artistic metal work, £32; artistic leather work, and poker work or pyrography, £10. In order to encourage as far as possible art industries in Ireland, the committee make no charge for entering exhibits in any of the classes, and as a further inducement to compete for the prizes, facilities are afforded for the sale of the articles exhibited.

The Exhibition is essentially an Exhibition of Irish Art Industries, and, as is stated in one of the rules, each competitor must be resident in Ireland.

Lists of prizes, containing all information, may be had on application to the Registrar, Royal Dublin Society, Leinster-house, Dublin.

Correspondence.

MR. CLIFTON ROBINSON'S PAPER ON "ELECTRIC TRACTION."

Unfortunately I was unable to be present on the 19th ult., when Mr. Clifton Robinson read his paper on "Electric Traction."

There are, however, a few remarks which I should like to make on the paper, as it appears in the *Journal* of the 21st ult.

Under the head of "Railways *versus* Tramways," Mr. Robinson says, that "Tramways are *feeders* not *rivals* to railways."

The truth of this remark, though evident to tramway men, has at last begun to be grasped by the general public; and especially by those who avail themselves of suburban tramways to get access to the railway stations, in order to make their day's journey. But even to the railway traffic manager is it becoming evident. Although but few of them are yet ready to admit (as I heard the general manager of one of our principal railways do quite recently), "that he considered the question of railways and tramways to be *the* question of the day; and that it had to be faced. And in doing so, that it would be far better to effect it in a friendly spirit, co-operating with each other to their mutual advantage; and not in a spirit of competition."

The other point raised by Mr. Robinson is that of "Corporation *versus* Company." And here I must differ altogether from Mr. Robinson, who seems to think, that corporate bodies are unbusinesslike in their operations, and incapable of acting conjointly with one another.

But, as the result of my own experience, extending over some thirty years, with many local authorities, both large and small, I must demur altogether to Mr. Robinson's strictures.

There are some cases, where, by Parliamentary authority, *obtained direct*, joint boards of local authorities have been doing good work for gas, water, and sewage matters. But when the word "electricity" is mentioned, the Board of Trade is, and has been for years past, the strong opponent of any joint action by local authorities.

Then again, Mr. Robinson seems to overlook the fact, that local authorities are hardly likely to welcome companies—especially electrical ones—whose almost avowed intention is to "pluck" the ratepayers to the utmost, when the day arrives, that the local authority has to buy out "the man in possession."

This is evidenced, in several recent sale cases, by the enormous profits that have been realised by "the promoters."

Fortunately, cases are arising where several local authorities are working conjointly, not merely among themselves, but also with the promoters of *the company*; which company, thanks to present legal restrictions, seems to be almost a necessary prelude to the initiation of joint action by several local authorities.

Let us hope, that the cases of this joint action may increase and multiply—as certainly the public will benefit thereby, economically.

JAMES N. SHOOLBRED.

Obituary.

MAJOR-GENERAL SIR JOHN F. D. DONNELLY, K.C.B.—Sir John Donnelly died at his house in Onslow-gardens on Saturday, the 5th inst. He was born in 1834, and was consequently in his 68th year. He entered the Royal Engineers in 1853, and the year after he joined he went to the Crimea, where he served with some distinction, being twice mentioned in despatches, and receiving, besides the medal and the Turkish decoration, the ribbon of the Legion of Honour. In 1857 he began the association with South Kensington, which afterwards occupied his entire career. Sir Henry (then Mr.) Cole was occupied in the establishment of the South Kensington Museum, which commenced in 1855. Lieut. Donnelly was one of the young engineer officers whom Cole associated with himself, and of whose ability he made intelligent use in carrying out his schemes for the establishment of an art museum and the promotion of artistic and scientific education in this country. The two were for long intimately connected in their work, and each of them had a sincere regard for the other.

When Sir Henry Cole retired from the public service, the South Kensington office was reorganised, the posts of Secretary of the Department and Director of the Museum, both held by Cole, being separated. Sir Francis Sandford, who was then Secretary of the Education Department, was appointed also Secretary of the Department of Science and Art, and Major Donnelly became Director for Science. On the retirement of McLeod of McLeod, the Assistant Secretary, he undertook the duties of that office as well. On Sir Francis Sandford's relinquishing the dual post, Colonel Donnelly was appointed Secretary of the Department, and he held the place till his retirement in 1899. The whole system of science and art education grew up under Donnelly's directions, and it may be truly said that the success of the scheme for instruction in science was very largely due to him. He devoted himself earnestly to the elaboration of a practical method, nor was it until other suggestions had been found unworkable that Donnelly's ideas were adopted and found adequate to the needs of the time. It was, in fact, only when Donnelly took the matter in hand that the teaching of science to the artizan class proved practicable. He retired from official life in 1899, having in 1893 been made a K.C.B.

It was in 1860 that he became a Member of the Society of Arts, but it was not until ten years later—in 1870—that he first took office on the Council. In the following year (1871), he brought forward the scheme of technological examinations which, carried on for some years by the Society of Arts with limited numbers and no great popular success, formed the foundation of the City Guilds Institute for the promotion of Technical Education. In the formation of this Institute Captain Donnelly was consulted, and his advice had considerable influence upon its character, while it may be said that it was entirely owing to his urgency that the scheme of technological examinations formed part of the Institute. From that time forward he remained, with such intervals as the regulations require, an active and valuable member of the Council, occupying the post of Chairman in 1894 and 1895.

The School of Art Wood-carving was established by his exertions. At his instigation a class was first started by the Society of Arts, and he afterwards succeeded in obtaining from some of the City Companies and elsewhere sufficient funds to carry it on to the present time. But a few months ago he was busily engaged in obtaining accommodation for the school on the premises of the School of Art Needlework, and in securing for it a more permanent organisation than it has hitherto succeeded in attaining.

It was at his instance that the Society undertook the organisation of the very successful International Congress on Technical Education in 1897. Application had been made to the Government asking them to hold such a Congress in England, and when the Government declined the invitation Sir John Donnelly suggested to the Council that the Society might undertake the duty. This, with some financial assistance from certain of the City Guilds, it did, and Sir John Donnelly rendered useful aid in the carrying out of the proposal.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

APRIL 16. — "Photography as Applied to Architectural Measurement and Surveying." By J. BRIDGES LEE, M.A.

APRIL 23.—"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S. SIR WILLIAM ABNEY, K.C.B., F.R.S., will preside.

APRIL 30.—"The Timber Resources of the Australian Commonwealth." By EDWARD T. SCAMMELL. SIR JOHN F. L. ROLLESTON, M.P., will preside.

MAY 7.—"Origin and History of Carriages." By ALBERT CHANCELLOR, J.P., Master of the Coach Makers Company.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 17.—"Recent Developments in Punjab Irrigation." By SIDNEY PRESTON, A.M.Inst.C.E., C.I.E., Chief Engineer, Irrigation Branch, P.W.D., Punjab. SIR DENNIS FITZPATRICK, K.C.S.I., will preside.

MAY 8.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT. SIR EDWARD A. SASSOON, Bart., M.P., will preside.

APPLIED ART SECTION.

Tuesdays, at 8 o'clock :—

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments."

Lecture I.—April 14.—Optical images—Their nature and formation—Reflexion and refraction—Prisms and lenses—Conditions required—Spherical aberration—Astigmatism—Focal lines—Chromatic aberration—Achromatism—Distortion—The refracting substance—Glass and its manufacture up to 1882.

Lecture II.—April 21.—The microscope—Simple theory—Conditions of problem—Direct refraction—Spherical aberration and its correction—Chromatic aberration and its correction—Secondary and tertiary spectra—The dispersive constants of glass—Modern glass.

Lecture III.—April 28.—The photographic lens—Simple theory—Conditions of problem—Oblique refraction—Astigmatism—Coma—Chromatic aberration—Distortion—Dispersive power and refraction—Modern glass.

Lecture IV.—May 5.—The telescopic objective—Conditions of problem—Photographic objective—Telephoto lens—Materials other than glass—Line of future advance—Modern glass-making—Tests of optical glass—Nomenclature.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Richard T. Glazebrook, "Glass for Optical Instruments." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. H. Hooper, "Compensation for Fruit Planting."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. W. Gamble, "Screens and Diaphragms for Half-Tone and Three-Color Work."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, April 15...Royal Institution, Albemarle-street, W., 3 p.m., Dr. A. Macfadyen, "Recent Methods and Results in Biological Enquiry." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on papers (*a*) Mr. W. C. Copperthwaite, "The Greenwich Footway-Tunnel." (*b*) Mr. Arthur H. Haigh, "Subaqueous Tunnelling through the Thames Gravel: Baker-street and Waterloo Railway." 2. Mr. Francis William Webb, "Locomotive Fire-Box Stays."

Asiatic, 22, Albemarle-street, W. 3 p.m.

Statistical, 9, Adelphi-terrace, 5 p.m. Geo. H. Wood, "Factory Legislation considered with reference to the Wages, &c., of the Operatives protected thereby."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. W. P. Pycraft, "Contributions to the Osteology of Birds—Part V. Falconiformes." 2. Mr. F. E. Beddard, "The Windpipe and the Heart of the Condor." 3. Mr. Hesketh Prichard, "Field Notes upon some of the larger Mammals of Patagonia."

Colonial, Whitehall-rooms, Whitehall-place, S.W., Sir Hubert E. H. Jerningham, "Colonial Administration."

Wednesday, April 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Bridges Lee, "Photography as Applied to Architectural Measurement and Surveying."

Meteorological, 25, Great George-street, S.W., 7½ p.m. Capt. D. Wilson-Barker, "Clouds."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. "Exhibitions of Pond Life."

Entomological, 11, Chandos-street, W., 8 p.m. 1. Miss Alice L. Embleton, "The Economic Importance of the Parasites of Coccidæ." 2. Col. Charles Swinhoe, "Eastern and Australian Geometridæ in the British Museum Collection."

Archæological Association, 32, Sackville-street, W., 8 p.m.

National Indian Association, Imperial Institute, South Kensington, S.W., 4½ p.m. Annual Meeting.

Thursday, April 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Sidney Preston, "Recent Developments in Punjab Irrigation."

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. A. C. Seward and Miss Sybil O. Ford, "The Anatomy of *Todea*, with Notes on the Affinity and Geological History of the Osmundaceæ." 2. Mr. G. M. Thomson, "The New Zealand Phyllobranchiate Crustacea Macrura."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. J. T. Hewitt and J. H. Tervet, "Oxonium Salts of Fluoram and its Derivatives." 2. Messrs. G. G. Henderson and D. Prentice, "The Influence of certain Acidic Oxides on the Specific Rotations of Lactic Acid and Potassium Lactate." 3. Mr. N. H. J. Miller, "The Amounts of Nitrogen as Ammonia and as Nitric Acid, and as Chlorine in the Rainwater collected at Rothamsted." 4. Mr. N. H. J. Miller, "The Amounts of Nitrogen as Nitrates and Chlorine in the Drainage through Uncropped and Unmanured Land."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Oxygen Group of Elements." (Lecture II.)

Historical, Clifford's-inn-hall, Fleet-street, E.C., 5 p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Barry Owen, "The Gramaphone as an Educator."

Mining and Metallurgy (at the Rooms of the Geological Society), Burlington-house, W., 5 p.m. 1. Mr. G. R. Carey, "Gold Mining in Matabeleland." 2. Mr. F. J. Stephens, "Geology and Mineral Resources of Kumaon and Garhwal."

Friday, April 18...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Sir John H. A. Macdonald, "The Autor-car."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. H. C. M. Austen, "The Erewash Valley Widening and Toton Sidings."

North-East Coast Institute of Engineers and Shipbuilders, Sunderland, 7½ p.m. Mr. B. P. Link, "Co-operation and Mechanical Aids to Workshop Cost-Keeping."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. Mr. Robert E. Atkinson, "The Standardisation of Pipe Flanges and Flange Fittings."

Architectural Assoc., 56, Great Marlborough-street, W., 7½ p.m. Mr. A. Needham Wilson, "A Tour through the South of France."

Quekett Microscopical Club, 20, Hanover-square W.C., 8 p.m.

Saturday, April 19...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Cummings, "British National Song." (Lecture II.)

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FRIDAY, APRIL 18, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, April 21, 8 p.m. (Cantor Lecture.) Richard T. Glazebrook, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." (Lecture II.)

Wednesday, April 23, 8 p.m. (Ordinary Meeting.) Professor Silvanus P. Thompson, D.Sc., F.R.S., "Opto-Technics."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 14th inst., Dr. R. T. Glazebrook, F.R.S., delivered the first lecture of his course on "Glass for Optical Purposes."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, April 17, 1902; Sir Dennis FitzPatrick, K.C.S.I., in the chair. The paper read was "Recent Developments in Punjab Irrigation," by Sidney Preston, A.M.Inst.C.E., C.I.E., Chief Engineer Irrigation Branch P.W,D., Punjab.

The paper and report of the discussion will be printed in a future number of the *Journal.*

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 16th, 1902; Sir William H. Preece, K.C.B., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ali, Syed Akber, Firozabad, Agra, India.
Harrild, Horton, 25, Farringdon-street, E.C.
Hugo, Johannes Daniel, 64, High street, Worcester, Cape Colony, South Africa.
Schumacher, Raymond W., Messrs. H. Eckstein and Co., P.O. Box 149, Johannesburg, Transvaal, South Africa.

The following members were balloted for, and duly elected members of the Society:—

Acheson, Edward Goodrich, International Acheson Graphite Co., Niagara Falls, New York, U.S.A.
Bertram, John Ross, 101, Clive-street, Calcutta, India.
Cooper, Richard Powell, D.L., Shenstone Court, Lichfield, and Ashlyns Hall, Berkhamsted.
Da Costa, José Simão, P.O. Box 208, Parà, Brazil, South America.
Perrin, Henry, 23, Holland-villas-road, W.
Plowden, Colonel Francis Hugh, care of Messrs. King, King, and Co., Bombay, India.

The paper read was—

PHOTOGRAPHY AS APPLIED TO ARCHITECTURAL MEASUREMENT AND SURVEYING.

By J. Bridges Lee, M.A.

Most people are in the habit of looking upon photographs as more or less artistic or inartistic pictures destined to convey impressions more or less accurate or inaccurate of what things look like. Comparatively few people have yet acquired a habit of regarding photographs as accurate measureable records of external facts. The impressions which a picture yields may be, and often are misleading, while the relationship which exists between the picture and the objects, whose images are depicted, is always definite, and a little careful attention in arranging the conditions under which a picture is taken, will suffice to make easy the correct interpretation of the picture. What those conditions should be, and how to interpret the picture, will be best understood if we begin by trying to understand what is the geometrical nature of a photograph.

The first fact to notice about a picture is that it is a surface. A photographer can generally arrange to adjust the surface on which to take his picture in almost any position he pleases with reference to the objects he wishes to depict, and within limits he can modify the character of the picture surface.

For most practical purposes it is best to use flat surfaces only, because a flat surface is the simplest possible kind of surface to obtain and to use. Other surfaces such as the inside of a hollow sphere or of a cylinder, might be used for special purposes, but even if such surfaces could be easily obtained and readily adjusted in correct position with reference to the lens at the time of exposure, and to the eye when under subsequent examination, the advantages of such surfaces would be much more than out-balanced by those of the ordinary flat surface for nearly all ordinary purposes.

As regards irregular surfaces there is nothing to be said in their favour. We will therefore consider flat surfaces only.

The first important generalisation we can arrive at is that the picture surface can only be an exact copy of the thing depicted when that also is a similar surface, and only then when the picture surface was parallel to the object surface at the time when the picture was taken.

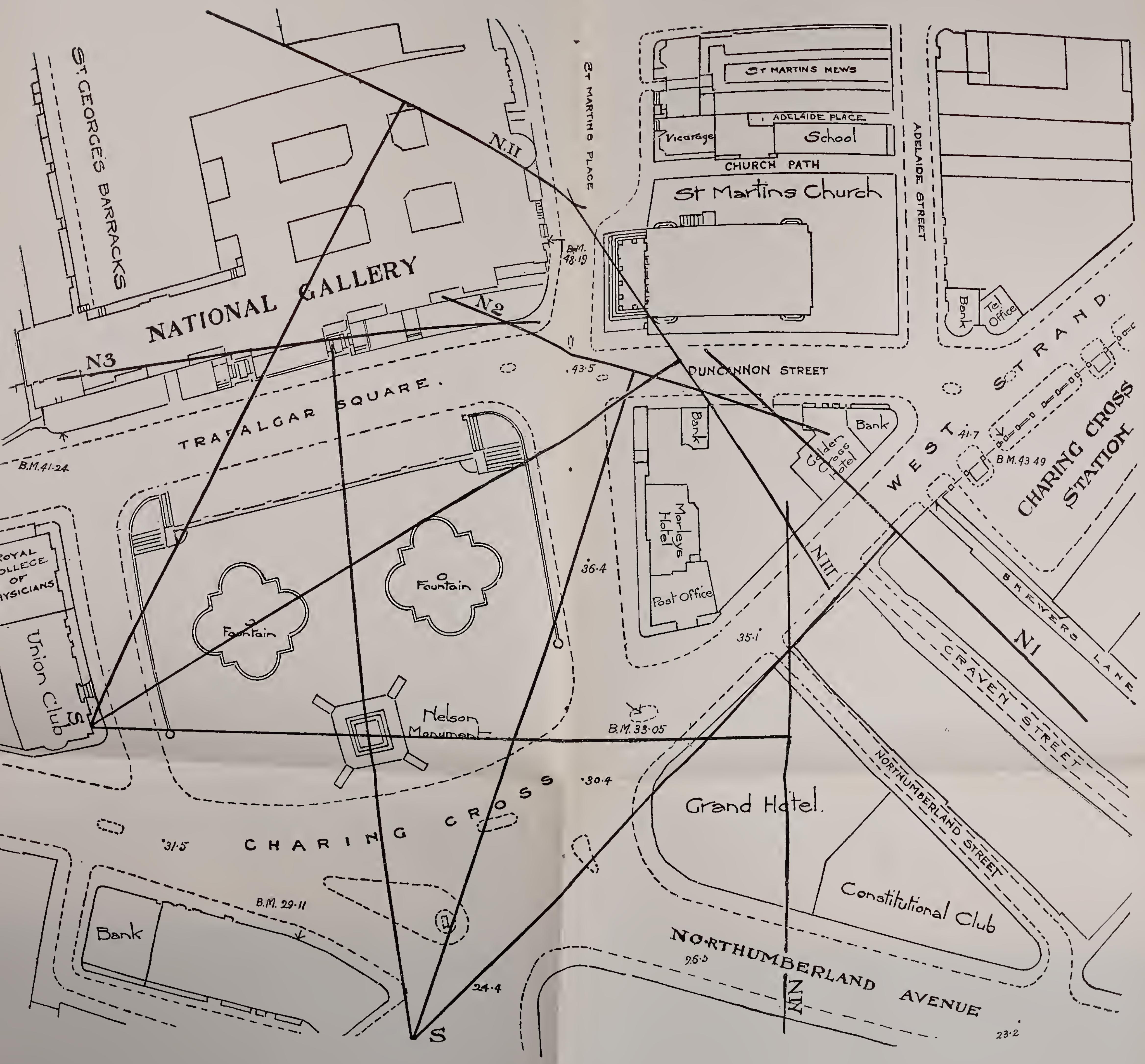
Before going further it is necessary to have a clear appreciation of this generalisation and of some simple consequences which follow. Most people know that handwriting, manuscript, type-printed matter, and drawings can be copied exactly by photography, and we continually see photographic enlargements which we can perceive at a glance and prove by measurement are proportional in all directions to the originals from which the copies were made.

To illustrate the first elementary principles of our subject let us first examine a photographic picture of straight lines and right angles arranged to form a set of regular squares. The lines whose images are now shown on the screen were originally ruled with a pen and ink on a flat sheet of paper which is here. That sheet of ruled paper was photographed in the ordinary way, due care having been taken to secure that the paper was fixed flat at the time of exposure and the sensitive plate surface parallel to the paper. A lantern slide was made in this way and that slide is now in the lantern by which this picture is being projected on the screen. The plane of the slide in the lantern is now vertical and parallel to this screen on which the image is received. There have thus been two photographic operations with different lenses, but the result in each case has been to show all the straight lines as straight lines and all the right angles as right angles. The original ruled drawing was made up entirely of squares, so is the lantern slide picture, so is the picture now on the screen. The squares in the slide are smaller than in the original drawing. Those on the screen are larger, but except in the matter of size all three are alike. There is no perceptible bending of any of the lines, no perceptible enlargement or diminution of any of the angles. This means that there has been no perceptible distortion in any part of the picture. With any good modern lens of the rectilinear type it is the rule that the picture is true and free from any perceptible actual distortion. We shall find different degrees of brightness of illumination, and, perhaps, difference in sharpness of definition between the marginal and central regions, but no straight lines will be bent, and no angles altered, and, therefore, no positions wrongly depicted. If the distance of the picture plane from the lens is changed the size of the squares will change, but not the shape, provided the surfaces are always parallel to each other. For sharp definition the focussing adjustment of the projecting lens may have to be altered, but no distortion will result. By simple measurement with a tape it can be shown that the length of the side of any square will vary in direct proportion to the perpendicular distance from a point inside the lantern lens to the receptive screen, assuming the relative positions of the slide and lens to remain constant, and therefore the area of any square will vary as the square of the distance.

This is the ordinary rule applicable to all rectilinear radiation from a point, whether it be light, heat, electricity, or any other form of radiant energy. We may therefore conveniently regard a photographic picture as a radiant production, every point of which is at the end of a straight line coming from an apical point somewhere in front of the picture. Generally that point is somewhere inside the body of the lens, but it may be outside and either before or behind the lens, and it is called the station point.

The picture yielded by the lens is the same as would be obtained by a simple pin-hole at the station point. A good lens gives a brighter

Supplement to the "Journal of the Society of Arts," April 18, 1902.



MAP OF TRAFALGAR SQUARE, CHARING CROSS, &c.

Illustrating the Method of Photographic Surveying.

and more sharply defined picture than a pin-hole, but otherwise the pictures are the same in size and outline.

The geometrical relationship between objects and photographic images of those objects can be most easily appreciated if the lens is supposed to be replaced by a pin-hole in the right position. It is then evident that the pin-hole aperture will be at the apex of a double cone of rays, the cone on one side of the aperture being made up of rays travelling from the object points to the hole, and the cone on the other side will consist of a prolongation of those rays beyond the hole until they meet the picture surface. (As a matter of fact, with lenses the apex of the cone of incoming rays is not coincident with the apex of cone of picture rays, but the two cones are similar, and usually the distance between the apices was not sufficient to affect materially the results, except under unusual conditions.)

With this conception always in mind that a photographic picture is a collection of points at the ends of straight lines radiating from the station point in the same directions as corresponding straight rays of light which have originally travelled from the objects depicted to that point, or its adjacent counterpart, a correct understanding of many of the problems of photographic geometry becomes simple and easy. It becomes clear at once that when the true position of a picture is known with reference to its station point any number of direction lines from the station to points on the objects depicted can be ascertained with ease, because they will be the same as the direction lines from the station to the corresponding points on the picture. To fix the actual positions of the object points it is sufficient to know their several directions from a known point and the distances of those points along the direction lines. Generally it is not convenient or easy to determine directly the distance of a point along a radius of direction. The most convenient and best way for general purposes is to find the horizontal distance first, then the altitude, when the actual linear distance will be the hypothenuse of the right angled triangle of which the horizontal distance and altitude are the sides containing the right angle. To find the horizontal distance a method of intersection similar to the plane table method of land surveying is used. Photographs of the same objects are taken from different stations. The direction rays to any point whose position is required are observed and projected on a ground plan when the intersection of the projected rays will mark the position of the point on the ground plan.

The altitude can then be ascertained by determining from the picture the angle of elevation and then computing the height which would subtend the observed angle at the distance already ascertained on the ground plan. Also the altitude will be a fourth proportional to three lengths, which can be measured directly. These are (1) the distance from the station to the projection of the image point on the horizontal trace of the picture plane. (2) The horizontal distance of the point from the station measured in scale feet on the plan. (3) The measured height of the image of the point on the picture above or below the horizon.

Or it may be determined by substituting values in a general formula $h = d \tan \alpha$ where h is the altitude above or below the station, d is linear horizontal distance, α is the angle of elevation observed from the station and $\tan \alpha$ is $\sqrt{\frac{y^2}{f^2 + x^2}}$ where f is focal distance, and x and y are abscissæ measured from the centre on the horizon and principal vertical lines as rectangular co-ordinates.

In practice there are no considerable difficulties, provided we have enough accurate information about the pictures which are used.

Most of the troubles which were experienced in former years in practical photographic survey work (apart from purely photographic difficulties and uncertainties, which were considerable in early days) have been connected with the ascertainment of the essential facts about each picture necessary to be known or ascertained somehow before the picture could be practically used for accurate survey work.

Professors Schiffner, Steiner, Hauck, and other Continental geometricians have published, from time to time, very able, original, and learned investigations of the more intricate geometrical properties of photographs; and it has been shown how, by aid of the five-point and three-point problems, and other geometrical and analytical methods, it may be possible to ascertain enough necessary facts about a picture to be able to make use of it for defining positions, even though the information, to start with, was defective in various ways; but for ordinary purposes it is necessary to obtain the requisite information by quicker and simpler means.

The essential information needed may be arranged under a few heads:—First, it is necessary to know from what spot the view was obtained; in other words, the exact position of the station point. This should be noted when the picture is taken.

Secondly, the position of the plane of projection, or the picture plane, with reference to the station. To define this position with accuracy, we need to know—(*a*) The inclination of the plane to the horizon; (*b*) [the orientation; (*c*) the distance of the picture plane from the station point.

(*a*.) Is generally vertical. There are many and great advantages in working with truly vertical pictures only for nearly all purposes.

(*b*.) The orientation may be found by reference to images of known points whose images appear in the picture, or the compass bearing may be automatically recorded at the time of exposure.

(*c*.) Is the focal distance or distance line of the perspective. The focal length of the lens used is generally a known and constant quantity for all distant views. For enlargements it has to be computed, and it is generally advisable that the picture should bear on its face marks from which the computation can be easily made.

Thirdly, the traces of the horizon and principal vertical planes intersecting at the centre. In practice there are very great advantages in having these lines automatically traced on the picture. Evidently also it is not sufficient to know only the position of the plane of projection with reference to the station, it is necessary to know also the position of the picture in that plane.

The centre and the principal horizontal and vertical lines fix that position. Reference to some photographs of part of Trafalgar-square and a map of the square and buildings round it will help to make some of these matters clear.

[Here a view from Drummond's Bank towards St. Martin's Church, and also map of Trafalgar-square were projected on the screen, and Mr. Bridges Lee explained how a photograph is used to obtain direction lines, &c., for plotting intersections, and explained in detail how to ascertain the height of St. Martin's Church from the picture.

The other photographs as here given were then shown.]

It will be seen that the horizon line in every case marks the level of the station right across the picture and forms the base from which all altitudes can be measured above or below the level of the station. If the points bisected by a horizon line be plotted on a plan, a line through those points will be a contour line of the same altitude as the station. By moving the station a known number of feet up and down, other contour lines can be obtained at any desired distances apart.

The methods so far considered and explained in outline, relate only to the fixing of points on a ground plan by the method of intersections and of elevations by the particular methods described. These methods are almost universably applicable, and with moderate care they yield very accurate results with much less expenditure of time and money and effort that would be needed for an ordinary survey of the same ground with a plane table, or any of the other known methods of surveying. In Canada, this method has been largely used, and it has been found that the actual money saving from using the photographic method, was two-thirds of the computed cost of a plane table survey. A similar saving has been computed as the result of using this method for the survey of the Trans-Baikal Railway in Siberia, and it seems reasonable to believe that with the improved instrumental appliances of the present time, and others perhaps to follow, the saving of expense for surveys hereafter, will be from 80 to 90, or perhaps even 95 per cent. of the cost of similar surveys in the past by old-fashioned methods.

When dealing with landscapes it is necessary to work for the most part by plotting selected points only, and sketching in details between the plotted points. Photographs from different stations over the same area give to the surveyor in his office the general aspect of the region, as seen from different points, for immediate comparison. They help him very much to fill in details by estimation, and provide him with ready means for checking his own or others' maps, by setting off any number of rays he may please, to points whose positions may be in any doubt.

Existing maps cannot be checked, or corrected, or amplified by any other means without the necessity for first sending an expedition to the place, which is not always possible for military or other reasons. If a set of good survey photographs is obtained they can be brought into use at any time and anywhere, to yield just any topographical information which is wanted at the time when it is wanted, including, among other things, reliable information about the appearance and general character of the ground, which it is often very important to know.

VIEWS FROM SOUTH STATION.

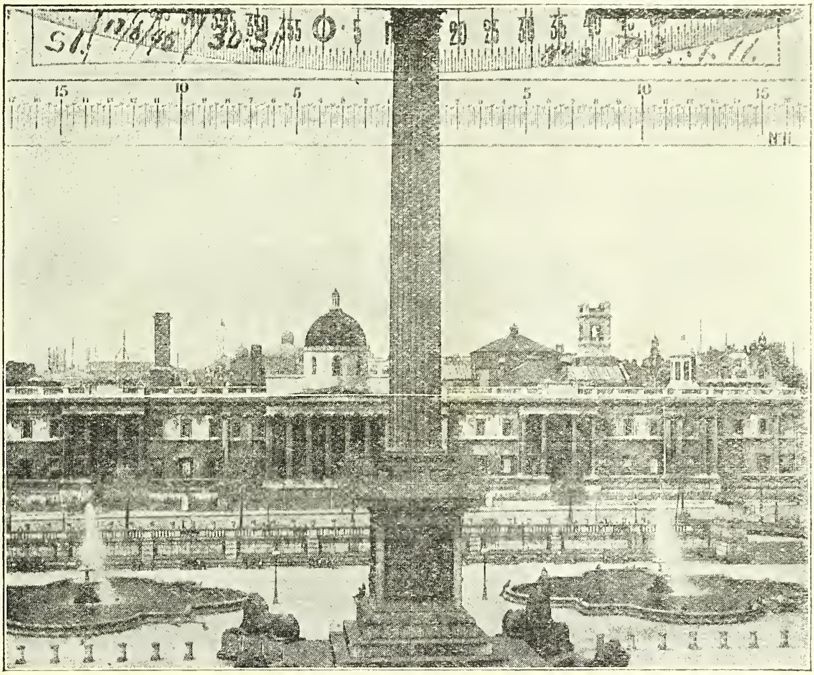


FIG. 1.

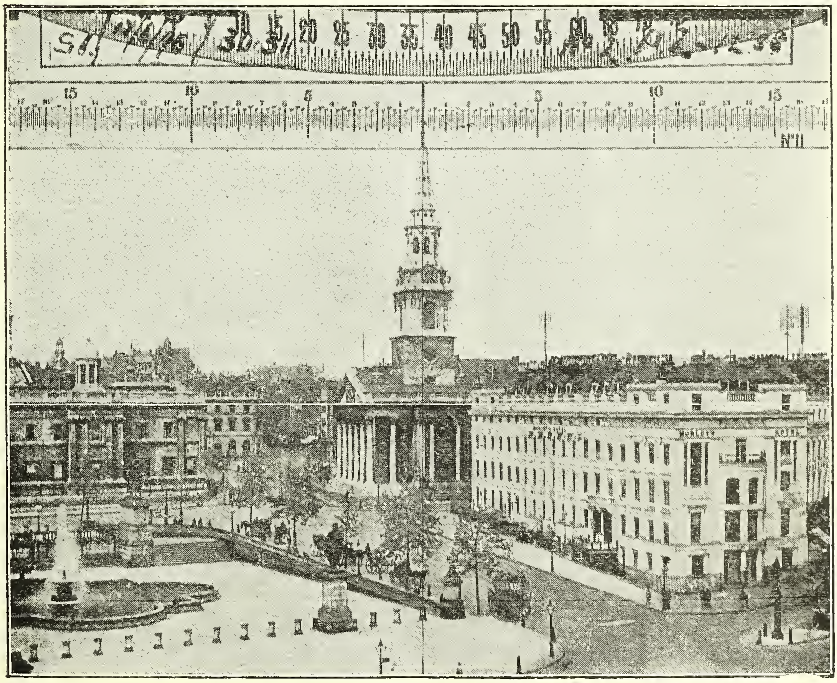


FIG 2.

Views from South Station—(*Continued*).

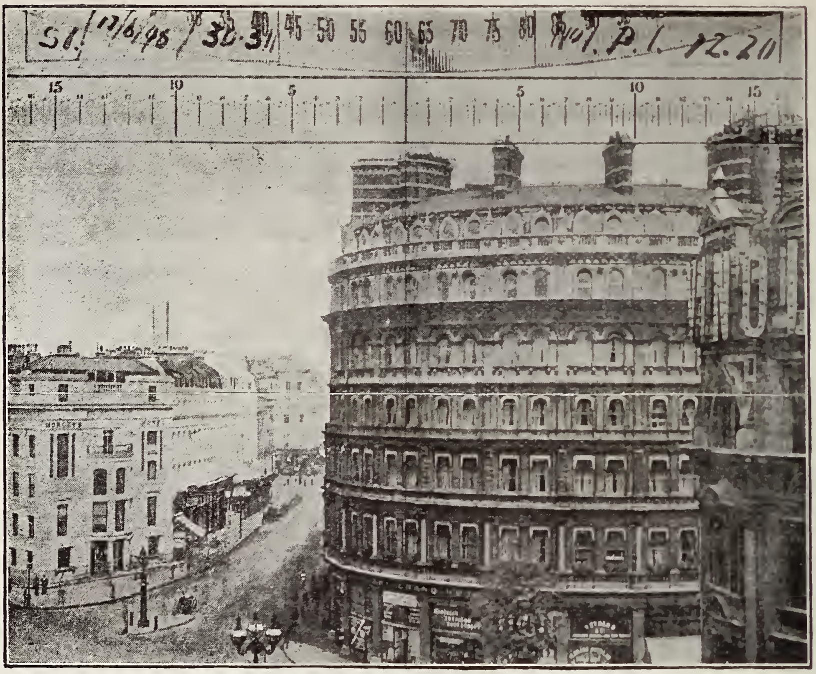


Fig 3.

Views from West Station.

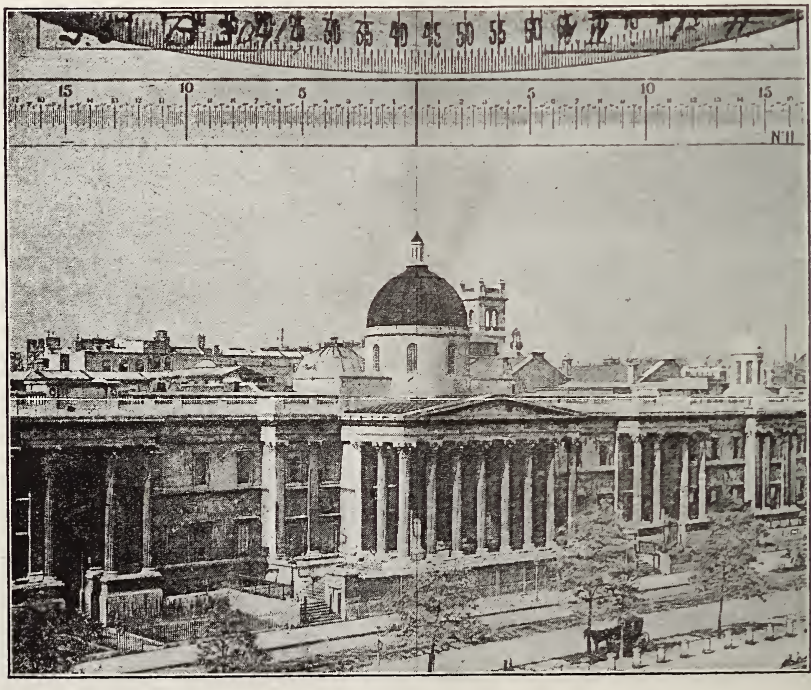


Fig. 1.

VIEWS FROM WEST STATION—(*Continued*).

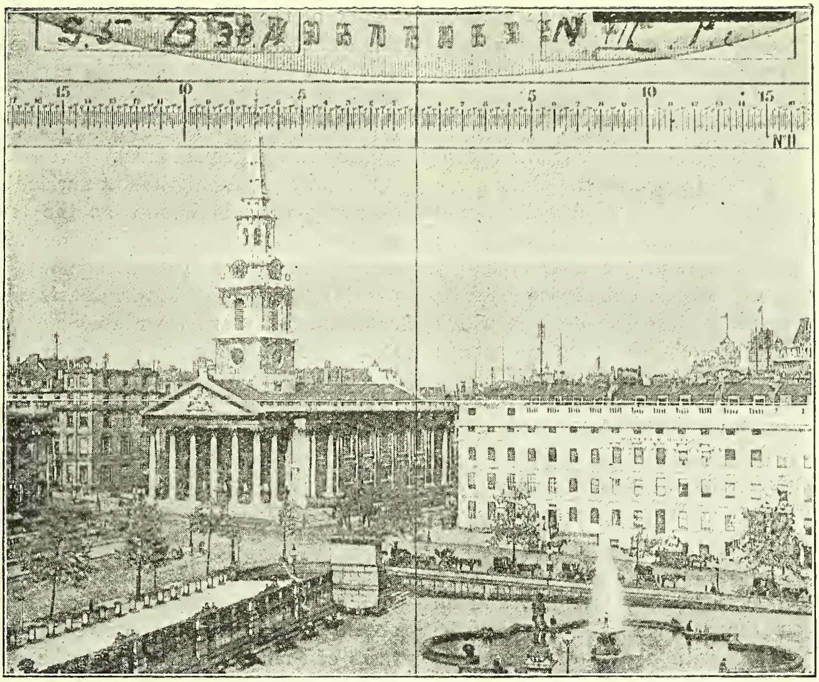


FIG. 2.

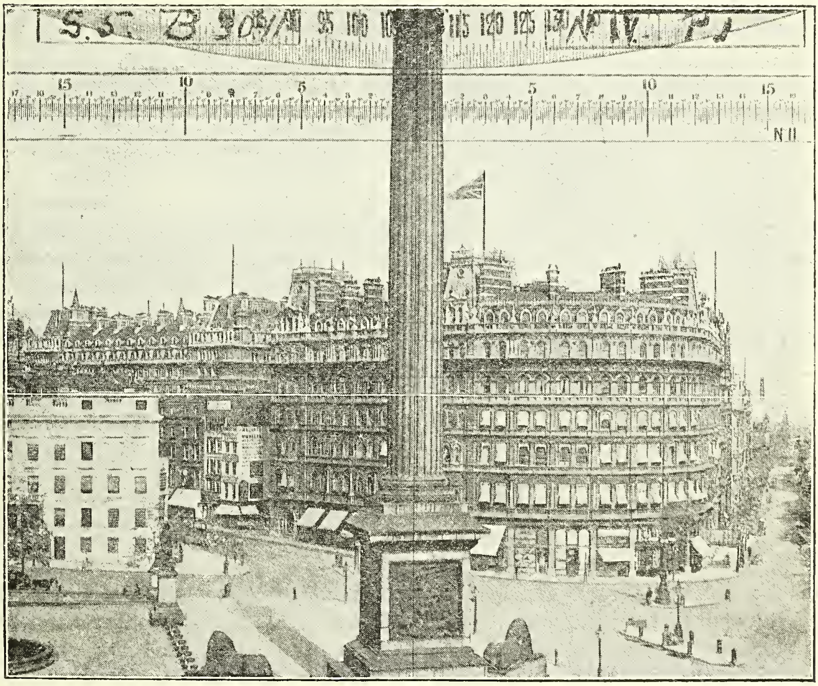


FIG. 3.

Sometimes, in landscape views, there are to be found level and perpendicular surfaces, and straight lines and rectangles, which may be conveniently dealt with on principles of perspective, a few of which it may be convenient to refer to now in connection with the interpretation of photographs of buildings.

In the early part of this paper it was shown how a surface parallel to the picture plane gives an image similar to itself in all directions and proportions, the scale being the only variable; and it has been shewn that the scale is simply the ratio of two measured distances—(1) from the picture station to the picture plane which is the same thing as the working focal distance; (2) from the object station to the object plane. When dealing with buildings it is often possible for the photographer, without difficulty or much loss of time, to measure directly with a tape the perpendicular distance from the diaphragm of his lens to the wall of the building to be photographed. This distance can be noted on the picture. The scale can then be calculated and constructed in a few minutes, and all distances on the surface elevation can be measured directly with a pair of compasses and that scale.

Distances on parallel surfaces nearer or further away such as projections, porches, or deep set windows or other recesses, will require different scales of measurement according to their distances in advance of or behind the principal surface, or the same scale can be used for measurement, and the results divided or multiplied by a constant computed for the difference. Another way to get the scale is to place a rod of known length in close contact with the surface where its image will be entirely included in the photograph.

Sometimes it is not convenient to walk up to a building to measure the distance to it or to place a measured length against it. A very efficient plan then is to shift the camera a measured distance to the right or left parallel to the face of the building, and take a second picture, when if due care has been taken to set up the camera perfectly square in both instances the images of the vertical hair on the face of the building will include between them a slice exactly as broad as the measured distance between the two camera stations. [This plan for obtaining regular slices of views bounded by parallel vertical planes may be used with advantage sometimes when dealing with landscapes. It is, however, very necessary to be extremely careful about the orientation to secure exact parallelism.]

If the ground on which the camera stands is level with the base of the building, the height of the lens above the ground will be the same as the height where the horizon line cuts the building. This method is not often very satisfactory in practice because of uncertainty in so many cases about the identity of the ground level.

One way to investigate flat surface areas is to apply what is known as the method of squares. If we imagine a plane area to be entirely made up of small squares, then the position of any point in the area is sufficiently determined if it is known in which square it is located and what is its position in the square. When dealing with a front view it is sufficient to superpose on the picture a sheet of glass on which have been ruled or photographed a network of regular squares in elevation.

If the focal distance of the picture be known it is a very simple matter to compute the scale value of the squares for different distances of the object surface. When free access can be had to the building and its surroundings it should be easy in most cases to obtain pictures of such dimensions that the measuring squares shall cover definite, convenient, integral areas.

Next in order of simplicity of measurement to a simple frontal view of a plane surface will be a horizontal surface or plan. The image now thrown on the screen is a perspective view of a ground plane divided into regular squares. This diagram was originally drawn by hand on a flat sheet of paper, in accordance with the well-known rules of perspective, and it has been photographed for projection.

A photographic picture on a vertical plate of a regular horizontal square-tiled pavement would present a similar appearance. On a ground plan, all the small units of area included between the lines represent squares of equal dimensions, and it is evident that if an object is seen to be based in any particular square, its position is known, and can be plotted on square-ruled section paper without any trouble. The degree of accuracy will depend largely upon the size of the squares in perspective. In practice it is not convenient to make the squares excessively small, because of the additional difficulty of identification which may result. It is best to work with fair-sized squares; and having ascertained in which square a point lies to take special care to ascertain its exact position in that square. For practical work regular series of perspective squares may be engraved or photographed on flat sheets of glass to make what are called perspectometers, which can be laid in position on the photographs with the scale surface next the picture face.

These perspectometers need to be specially constructed with precise reference to the focal length of the lens in each case. The image now thrown on the screen shows what a perspectometer is like. A study of the perspectometer is instructive also in the way of shewing the general nature of photographic distortion of objects whose outlines lie in receding planes.

Time will not permit of the discussion of the interesting subject of so-called photographic distortion to-night. It must suffice for the moment to say that whatever the apparent distortions may be they are all in strict accord with the regular laws and principles of geometric perspective.

If a camera is squarely constructed, and a flat surface is squarely faced, there will be no apparent distortion at all in the image. If there are receding surfaces in the object they will be fore-shortened in the picture, and distant objects may appear too small, and near ones too large in proportion. These are facts which an experienced photographer learns by practice, and which he must bear in mind when seeking to produce pleasing or artistic pictures. The laws on which these facts depend are of universal application, and if rightly understood and applied with judgment, they enormously enhance the value of photography as a means of collecting and recording information about objects, and at the same time enable us correctly to read and interpret photographs as condensed accurate records of facts such as few other documents and no mere written descriptions can rival.

The method of squares which has been spoken of as applicable to the measurement and plotting of elevations and plans can be applied also for the measurement of other receding flat surfaces such as the roofs or walls of buildings.

The diagram now shewn on the screen will serve to illustrate this. It represents in perspective an axial view of the interior of a room with square cross section, the walls, roof, floor and far end of which are all divided into equal squares.

The distance line here is a radius of the circumscribed circle. The walls, floor and roof should appear exactly alike, because they are assumed to be exactly alike in reality, and the principal axis is parallel to and equidistant from them all.

I would venture humbly to commend this simple diagram to your attentive consideration and study at home and at leisure. You will find in it the key to a correct understanding of the chief fundamental rules and principles of perspective, and it will help towards a correct appreciation of the true relationship between photographs and objects photographed.

Various modifications of this type of diagram with station point changed to different measured positions away from the axis of symmetry but with the axis of vision parallel to the axis of this diagram, and other sets of corresponding diagrams with the axis at known degrees of obliquity, should suffice for an almost complete exposition of the theory and practice of rectilinear perspective.

Proficient perspective draughtsmen could, no doubt, prepare such diagrams with the ordinary drawing materials, and according to rule, or the same diagrams could be prepared with much saving of time and trouble, by aid of a well made surveying camera and a long rectangular room with mosaic covering or sheets of ruled paper or canvas, perfectly flat, and parallel, and perpendicular to each other.

If neither a specially prepared room nor screens are available for practice study, a level roadway between parallel brick walls or regular flat fronted houses, will answer very well for early experiments, which will soon lead to a clear perception of the fact that photographs are, in reality, true perspectives. It will soon be found, by experiment, that the image of every identifiable point is located where theory indicates that it should be, and where, indeed, it must be in obedience to immutable law, and it will be realised that just as it is possible to predict the exact arrangement of image points on a picture, from the known position of the object points, so conversely, it is possible to reason back from the picture to the object. Sooner or later the time will come when photographic projection will be systematically employed for teaching perspective, and it will be employed practically, on a large scale, for projecting images from one plane to another. Frontal planes or elevations can be directly projected in angular perspective, and *vice versâ*; and vertically inclined planes can be directly projected in plan or elevation.

If we have a perspective surface to measure, then squares, in similar perspective, superposed in correct position upon the picture image afford, in many cases, convenient means of measurement, and provided sufficient careful attention be given to necessary details, fairly accurate measurements and approximately correct outlines of objects can be thus obtained, but in a general way unless the dimensions to be ascertained are in planes parallel to the picture plane and at known or easily ascertainable distances from the station, it is not wise to depend on one picture alone for working out dimensions by perspective rules.

One chief reason for this caution is that the elements available on a single picture for determining depth or distance are not sufficient to secure accuracy except for very near distances.

The angles between visual direction lines and the reference planes of a single perspective are much too acute or obtuse to yield trustworthy intersections for distance.

For fixing positions by the intersection of direction lines a base is required whose length must bear some reasonable relation to the distance of the point to be fixed, and two photographs at least from different stations should be used for fixing positions. In practice a third view from a third station should be used when possible to check the results. Rectangular intersections are best and least need checking. These considerations are not at all new. Far from it. The reason for reintroducing them now is to correct possible misapprehension of what has been said before. Perspective is a fascinating and instructive subject for study, and it is quite legitimate to employ its principles for the investigation of external objects as depicted by photography, and no doubt the appropriate application of those principles will reveal to the accomplished student a much larger proportion of the geometric truths recorded by photography than will be revealed to the uninitiated, but expectation must not be pitched too high or in unreasonable directions or it will certainly lead to disappointment and discouragement. We must not expect to obtain full knowledge of unknown objects of three dimensions by aid of a single photograph, or even a number of photographs from a single point of view. To study unknown objects thoroughly we need to be able to examine them from several different points of view and to compare the views.

The use of photography does not obliterate this necessity, though it helps very decidedly towards correct final conclusions because it records faithfully and in obedience to definite exact laws which can be ascertained the appearance observed at every station, and these views from different stations can be brought close together and directly compared.

The next view on the screen is an illustration of an instrument similar in its essential features to the instruments with which the survey pictures shown to-night have been taken. I will not weary you with any detailed description of this apparatus because it is probably well known to many who are here to-night, and further there is an instrument here which is open to inspection by anyone who cares to examine it. The chief distinctive features which I believe to be important are to be found inside the box. They could be adapted without any difficulty to the most simple type of rectangular box camera, and the simple surveying camera thus made could be used effectively to give accurate measureable records, provided always that adequate means were provided for accurately levelling the box, and that reasonable care had been taken to secure accuracy of construction.

It may be hoped that in due time a simple standard type of working camera, fitted with a good lens and accurate recording mechanism, may find its way into general favour. The mechanism inside the box should be removable and replaceable at will, as this is, so as not to interfere with the general utility of the camera for taking ordinary artistic or other pictures, which are not intended to be measurable. In conclusion, I wish to tender my best thanks to the Council of the Society of Arts, and to those members and visitors who have honoured me by attending the reading of this paper. At the same time, I must beg your kindly indulgence for the many shortcomings in the paper itself. For the rest, I am profoundly convinced of the great possibilities of accurate photography developed along lines which I have endeavoured to indicate; and I would venture to predict that a time will come when in all civilised countries there will be accumalated regular libraries of standard readable pictures of all objects of architectural, topographical, or historical interest, and there will be men in abundance who will be able to read those pictures aright. On this, as on other lines of progressive development, let us pray that England will hold her own.

The ground plan of Trafalgar-square and neighbourhood, issued as a supplement to this number of the *Journal*, illustrates the best general method for plotting plans from photographs.

The points marked S are station points where the camera was placed when the pictures were taken.

The ruled lines radiating from those points are the axial directions of the views.

The lengths of those lines are the focal distances.

The ruled lines perpendicular to the axes are the traces of the picture planes on the plan.

The positions of all points which are common to views from both stations can be ascertained and plotted in their proper positions on the plan.

To test and confirm the accuracy of the plotting of individual points (specially those which are doubtful), reference should be made to views from a third station.

As the stations on the plan are at the south and west sides of the square, the best position for a third station would be at the east side.

DISCUSSION.

The CHAIRMAN thought the author had brought forward a subject which was absolutely novel not only to those who were not photographers but to photographers themselves. Probably there were many present who had examined with a great deal of care the snapshots and pictures taken in South Africa, and had wondered with what kind of a camera, what direction and time of day they had been taken. If the pictures had been taken in the manner suggested by the author everyone would have been the wiser. In travelling a short time ago through Sicily a friend accompanying him indulged himself in taking snapshots on every possible occasion. On Monte Reale near Palermo there was a magnificent old monastery which was probably the most beautiful specimen of ecclesiastical architecture in the world involving the use of tile work. His friend took a photograph of the cloisters attached to the monastery; but in the subsequent picture which was developed instead of the line of the cloisters being horizontal it was curved. He would ask the author to explain the reason for this. As an engineer he had listened with great pleasure to the suggestions made by Mr. Bridges Lee. The whole secret of the success of the engineering profession rested upon the accuracy of their plans, drawings, and figures, without which it was impossible to secure perfection of working. Sometimes it was impossible in taking a rapid survey of the country to adopt the usual methods of the engineer to secure accuracy; but if the author's invention was applied to the general process of surveying engineers would reap a great advantage. He had been forcibly struck with the author's explanation of the horizontal line and the vertical central line, the vanishing point in a picture. In his early youth he studied a little the art of perspective, since which he had never looked at a picture without asking himself which was the vanishing point and which the horizontal plane. It was marvellous when one determined those two points how the picture developed itself. It was not alone in examining a picture that a knowledge of the horizontal plane was of use. He remembered on one occasion ascending Snowdon with some English friends, and after going up about 1,000 feet, 1,500 feet, and 2,200 feet, he announced to his friends that they had reached those respective altitudes. His friends inquired how he could tell the heights. The reason was extremely simple. The horizon, the sea, was in front; the plane that passed through the eye passed through the horizon, and the tip of any mountain which just touched the horizon of the sea was exactly the same height as the eye; so that if one knew that a certain mountain was 1,000 feet, 1,500 or 2,200 feet high it was possible to tell from the height of the lower mountains as one ascended the higher mountain the height of the mountain being ascended. In conclusion he proposed a hearty vote of thanks to the author for the extremely interesting paper he had read.

The vote of thanks was carried unanimously.

Mr. BRIDGES LEE, in reply to the Chairman's question dealing with the curvature and distortion of the lens, said that if an ordinary uncorrected single lens was used, and if a stop was put in front or behind the lens, distortion was obtained. But if one used a lens made of two symmetrical parts with a stop between the two lenses, whatever distortion was due to the front lens would be exactly counteracted by the back. Rectilinear lenses were accordingly used, and a lens must indeed be a bad photographic lens which would not project straight lines as straight lines on a plane surface. If straight lines were projected as curves, a reason might be that the surface upon which the picture had been taken was a bulging surface. If the film in the camera cockled or the plate was not flat the straight lines were projected as curves. He wished to lay great stress upon the necessity, if effective progress was to be made in photography, of sticking as far as possible to true flat surfaces. In cameras with short focus lenses even a very little cockling in the film would cause a good deal of distortion in the picture. In some of the leading optical works on the continent scientific men had made very careful and exact investigations on the subject, and it had been found that the distortions even at the margins of a picture were practically infinitesimal and negligible quantities. In Switzerland a most wonderful map of the Alps had been made, and a short time ago some distinguished French engineers completed an absolutely new survey of Mont Blanc by photography, which was an improvement on the other survey. In addition, lines of railway had been set out in many parts of the world by the photographic method of survey, including a large part of the Canadian Pacific Railway and the Trans-Baikal Railway. In conclusion, he could not help thinking that among the developments of photography in the future there were none of greater importance than those he had brought forward, and was sure that if the subject he had introduced was further studied it would amply repay the attention given to it.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

APRIL 23.—"Opto-technics." By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S. SIR WILLIAM ABNEY, K.C.B., F.R.S., will preside.

APRIL 30.—"The Timber Resources of the Australian Commonwealth." By EDWARD T. SCAMMELL. SIR JOHN F. L. ROLLESTON, M.P., will preside.

MAY 7.—"Origin and History of Carriages." By ALBERT CHANCELLOR, J.P., Master of the Coach Makers Company.

MAY 14.—"Boats and Boat Building in the Malay Peninsula." By H. WARINGTON SMYTH.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MAY 8.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT. SIR EDWARD A. SASSOON, Bart., M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI.

MAY 27.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments."

LECTURE II.—APRIL 21.—The microscope—Simple theory—Conditions of problem—Direct refraction—Spherical aberration and its correction—Chromatic aberration and its correction—Secondary and tertiary spectra—The dispersive constants of glass—Modern glass.

LECTURE III.—APRIL 28.—The photographic lens — Simple theory — Conditions of problem — Oblique refraction—Astigmatism—Coma—Chromatic aberration—Distortion—Dispersive power and refraction—Modern glass.

LECTURE IV.—MAY 5.—The telescopic objective —Conditions of problem—Photographic objective—Telephoto lens—Materials other than glass—Line of future advance—Modern glass-making—Tests of optical glass—Nomenclature.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Richard T. Glazebrook, "Glass for Optical Instruments." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. A. N. Paterson, "Traditions in Architecture: its Function and Value."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. J. W. Williams, "The Concentration Camps in South Africa."

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Dr. J. Stefansson. "Iceland: its History and Inhabitants."

TUESDAY, APRIL 22...Royal Institution, Albemarle-street, W., 3 p.m., Dr. Allon Macfadyen, "Recent Methods and Results in Biological Enquiry." (Lecture III.)

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Francis William Webb's paper, "Locomotive Fire-box Stays."

Photographic, 66, Russell-square, W.C., 8 p.m.

WEDNESDAY, APRIL 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p m. Prof. Silvanus P. Thompson, "Opto-Technics."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. ("James Forrest" Lecture.) Sir William Chandler Roberts-Austen, "Metallurgy in Relation to Engineering."

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. Annual Meeting.

Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.

THURSDAY, APRIL 24...Irish Literary Society (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 8 p.m. Mr. J. Campbell, "An Old Irish Rath."

Royal, Burlington House, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Charles E. Keyser, "Some Ancient Wall Paintings."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Oxygen Group of Elements." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. Swinburne and Cooper's paper, "Problems on Electric Railways."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Sutherland Macdonald, "Tattooing."

FRIDAY, APRIL 25...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. J. M. Davidson, "X Rays and Localisation."

Civil Engineers, 25, Great George-street, S.W. 4 p.m. ("James Forrest" Lecture.) Sir William Chandler Roberts-Austen, "Metallurgy in Relato Engineering."

Architectural Assoc., 9, Conduit-street, W., 7½ p.m. Mr. E. A. A. Gruning, "Arbitrations."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Dr. Dawson Turner, "An Exhibition of a Mechanical Brake for Induction-coils." 2. Mr. R. S. Whipple, "A Temperature Indicator for use with Platinum-thermometers, in which Readings are Automatically Reduced to the Gas Scale." 3. Mr. S. A. F. White, "Note on the Compound Pendulum."

SATURDAY, APRIL 26...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Cummings, "British National Song." (Lecture III.)

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FRIDAY, APRIL 25, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Monday, April 28, 8 p.m. (Cantor Lecture.) Richard T. Glazebrook, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." (Lecture III.)

Wednesday, April 30, 8 p.m. (Ordinary Meeting.) Edward T. Scammell, "The Timber Resources of the Australian Commonwealth."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

Dr. R. T. Glazebrook, F.R.S., delivered the second lecture of his course on "Glass for Optical Instruments," on Monday evening, 21st inst.

The lectures will be published in the *Journal* during the summer recess.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

An examination in *vivâ voce* Spanish was held by the Society's examiner, Professor R. Ramirez, under the Manchester School Board at the Central Board School, Whitworth-street, Manchester, on the 9th inst., when 29 candidates presented themselves, of whom 23 passed and 6 failed.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, April 8; Thomas G. Jackson, R.A., in the chair.

The paper read was—

STREET ARCHITECTURE.

By Beresford Pite, F.R.I.B.A.

The street architecture of England can only refer now-a-days to the combined effect of the many various and unrelated buildings in our streets. We have no proper street architecture in the sense in which we may be said to have a domestic or ecclesiastical architecture of recognisable quality, possessing admitted characteristics born of tradition and new movement.

A broader description of civil architecture, including within the term buildings of municipal or semi-public character, will not alter materially our estimate, or permit us to claim for our towns and cities an architecture which we could in any general way define as coherent, traditional, or worthily characteristic of our national taste and refinement.

But our street architecture, such as it is, cannot help being representative of its producers, and of their ideals or lack of them, and, as there is neither lack of enterprise nor self esteem among us, particularly in the life of our street-building cities, the consideration of the external environments of this busy side of life may assist us in endeavouring to review the causes and effect of our lack of a street architecture, which should rank with that of our dwelling-houses and churches, and direct us to some ideals which may stimulate desires for improvement, and this should ensue upon the consideration of a condition which we have been led to admit is unsatisfactory.

Comparison with Domestic and Ecclesiastical Architecture.

We have premised that our ecclesiastical and domestic architecture has life and artistic value, for any review of the art of the Victorian era exhibits a revival from mere formal symmetry and application of types to vital influences of artistic adaptation to purpose with a pleasant reflection of the eclectic study of the traditional architecture of England. Education, culture, refinement, and literary taste are evident in the whole movement of the building arts and crafts during this period. The churches of the latter half of the 19th century, arranged chronologically and illustrated internally and externally, would present a gallery of architectural designs of amazing versatility and originality, and of quite wonderful beauty of picturesque dignity and charm of detail, rich in genuine beauty of workmanship and conception.

A similar result will be arrived at, with the exercise of some greater selection in the earlier period, by assembling an exhibition of English houses of all sizes, the homes indeed of the people of a profound peace and of unparaleled domestic prosperity and development. Stately or modest, romantic or homely, the same originality of conception, wide comfortableness, reasonableness, and perception of the beauty of domestic life will be generally apparent, while in the details of decoration and furniture, artistic impulse and architectural character have led to a real revival of the handicrafts, and endeavours to make the commonest utensils of home life beautiful to eye and hand, ennobling alike the designer and the user.

It may be remarked incidentally that the manifested vitality of this English architecture has met with recognition at the hands of continental critics, and that in ecclesiastical and domestic art we have an admitted mastery that has produced energetic followers and admirers in different directions.

It must be observed that the two branches of building art upon which we are touching have originated in one class of society, and in very many ways reflect its social conditions and ideals.

The same upper and upper middle class have provided the examples alike of church and house building, and the movements of thought expressed in this architecture are of the refined education and literary taste—let us say—of those who have derived their ideal and sense of culture from university life, and from opportunities of historical study. The breadth of view and freedom of thought, the criticism and eclecticism of the passing day are present in its architecture as in its literature, for all who can read the characters employed in their expression; an easy illustration of this can be offered in the sustained devotion to mediæval tradition both of the architect and of the ecclesiastic. In all the work of this representative class there is the characteristic of a powerful craving for a sense of style, a self-consciousness foreign to real Gothic art, but as current in the buildings as upon the lips of client and architect, and with this a strong personal note of individualism and independence which, by persistent differentiation both of example and type, have made the architects men who seek for originality without creative matter, and for conformity to style without the opportunity of realising that environment of characteristics upon which completeness of artistic style depends.

The sense of refinement in this architecture has become so much a characteristic quality to be sought for, marked down, and expressed, that native simplicity has become replaced by a laborious affectation which has danger in its artificiality, though its note of revolt against the tendency of the world at large to vulgar elaboration of effect, is of great value.

STREET ARCHITECTURE, COMMERCIAL.

As our subject is not the consideration of civil architecture, we exclude public buildings, although they form part of many street perspectives, and with some reservations, cannot consider at any length the dwelling-house of the modern street—such streets of dwellings usually described as "parks" or "gardens," which might suffer in reputation by a more sincere classification—leaving for our discussion the buildings that compose the business quarters or centres of our cities, which may be safely defined as those of the commercial world, wholesale, retail, warehouse, store, and shop, together with their necessary manufacturers', companies', and insurance offices, banks, and accommodation for the professional men, who are essential to business life. It is, therefore, the business community which is mainly responsible for, and indeed originate our street architecture, for whose wants it is designed, and by whose ideals it is controlled. This commercial class is the backbone of our national life and prosperity, and upon it depends that measure of wealth without which architecture, as at present practised, could not exist. It has represented until now the pre-eminence of England, and we shall expect to discover, if we have time for analysis and search in its architecture, so much of this part of the secret of England's greatness as is capable of translation into the terms stone and brickwork expression.

Comparing the architecture of the ecclesiastic and of the country gentlemen with that of the business man, we would naturally anticipate finding that the predominating tastes of the one are sentimental, and of the other, practical or unsentimental. Art is so wholly a matter of sentiment—we might almost say it is pure sentiment of high and noble character, and architecture therefore largely, though not wholly so, that we might, without surprise, discover that the street building of our commercial centres was entirely unsentimental, and architectural only in being wisely and designedly practical.

If we could plant a Utopia where, as a condition precedent of existence, subsistence was provided independently of the exercise or practice of art, we would devoutly wish the consummation that buildings only partaking of sentimental character should be designed by architects, and the streets devoted to unsentimental commercialism and its dependents, erected by mere surveyors. That these would be ideally beautiful architecture in so far as they were soundly built and truly adapted to purpose without the affectation of sentimental art I for my own part sincerely believe. The practical business man, however, takes the world as he finds it and conforms his labours to its requirements, and we, admiring the truly practical when it is practically true, must accept the street architecture of commercial purposes as it is, and suit our labours to its peculiarities.

The world, as observed by the keen eye of commerce, has a love of beauty—that is, of colour, of variety, of ornament. The Manchester print finds the best market in Africa if gorgeous, and ordinary articles of household use from smallest to greatest sell better if ornamented, just as they sell better if cheap ; in fact, it is to be observed that cheaper articles can be obtained having more ornament upon them than costly ones, cheapness and beauty of the commercial sort going hand in hand, what is intrinsically better being extrinsically worse, that is deemed less worthy of decoration. The commercial world is at present so, its relation to true art anomalous and contradictory, but we hope yet under some preliminary pulsations of conscience upon the subject ; at all events in the home market ; though radically wrong in its conception of art as such. Art exists practically, and it is therefore grasped by the commercial hand, but its character changes in the touch from a pure sentiment to an advertisement, and in this very different aspect we meet it in our street architecture.

GOOD DESIGN COMPATIBLE WITH REQUIREMENTS AND MODERN MATERIALS.

It may be well before going further to emphasise the necessary doctrine that good building design, that is, good architecture, is not incompatible with the best adaptation to use, convenience, and healthiness of arrangement. No definition of architecture should be allowed that would limit, in the presumed interests of art, for instance, all the access of light that business premises demand, either in the size or position of windows. Should it be necessary to have the entire frontage of a building occupied with window surface, so far as the limit of the law allows, an architect would assume an entirely false standpoint should he declare that this purpose is contrary to art, though if he decides it necessary to limit the openings by constructive considerations he would be unquestionably within the sphere of his proper authority. Even architectural proportion—that subtle and almost indefinable quality of adjustment which gives pleasure—is itself based upon factors of service. For example, the apparently good proportion of a column depends upon a recognition of the substance of its material, for a well-proportioned wooden column would almost certainly become unsatisfactory, of the same proportions erected of stone or brick. The traditional conventions of the so-called orders of classic architecture had their origin in the refined adaptation of supports to spaces owing to the necessary limitations of length and depth in the stone lintels which connected the columns. There is nothing radically inimical to satisfactory architectural proportion in any necessary acceptance of the large spaces requisite, and recognised as essential, for the window surfaces of shops or show-rooms in warehouses upon the street fronts of the buildings.

The frank acceptance of the most serviceable and convenient materials for the peculiar requirements of commercial buildings is not under any circumstances to be avoided as inartistic. In a public building of a quasi-monumental character and of varying use stone columns or arcades would have an architectural value and suggestiveness both in their forms and material. Association and tradition have in such cases much to borrow from ancient historic precedents, and a sheer modernism of idea would probably be alien in spirit to the *genius loci* and associations of the building. But in business architecture the converse is more usually the case, the commercial world can only in rare instances maintain ancient forms or style ; the movement in trade of all kinds is to the newest and latest style, and the pressure of the time not only in economy of production but in rapidity of distribution, is felt in every direction.

The employment of iron and steel fireproof construction for supports and lintels in the front as well as in the interior, the use of large sheets of plate glass, and the carrying of great masses and weights upon narrow steel stanchions are instances of special treatment, for which a pedantic architecture will not succeed in discovering conformable types in antiquity, though the same principles of truth, to which pedantry is blind, are to be observed if sought for in all genuine architectural forms. A progressive and living art of building has everything to gain from any new or increased suitability of its materials to the ultimate uses of the building.

We must assume that there is as much honest picturesqueness of true character about a modern warehouse front of rolled iron and plate glass as in the timber-framed construction and leaded-quarried glazings of its ancestor of the Elizabethan period, then newly erected for the developing woollen trade of England, and similarly occupying whole surfaces of street frontage with small quarried glazed windows and a multiplicity of subdivisions necessitated by the over-hanging construction—a contrivance designed to increase floor space upon a limited site.

The advent of an employment of rolled iron joists in our building art, with a latter development of complete steel-framed construction, marks an era upon the threshold only of which we now stand. The significance of this new aid to building nay be estimated perhaps by reference to the truly astonishing high buildings of the United States. Nothing in architectural history can compare in importance with this development since the re-discovery and application of the dome to buildings of magnitude by Brunelleschi and Michael Angelo at the Renaissance. That sudden and amazing stride into a new domain of construction when building art appeared to have exhausted its own development, is alike in extent and application to the almost spontaneous generation of high street buildings in America. The purposes and authors of the one class and of the other contrast picturesquely and characteristically enough, the evolution of conscious building art, cultivated by lofty ambition to do service to the universal ecclesiastical State policy of Christendom on the one hand, and on the other the indomitable peristency of invention, stimulated and spurred to all utmost developments by the commercial enterprise of a continent of seemingly exhaustless resources. Compare Michael Angelo with the "Soaring Bird of Freedom!" In the old country, however, the soaring qualities of steel-framed construction are limited by considerations which we need not discuss, for among the advantages of living in a city of the old world are to be counted an equitable right to the access of light and air within one's building, and in narrow streets this involves a limitation of nearly every body else's right to soar in building materials, and as the general sanitary conditions of the street are affected by the preservation of sunshine and air, this has become one of the many cares of "our excellent grandmother."

THE ARCHITECTURE OF IRON CONSTRUCTION.

Iron and steelwork have, however, entered so fully into the marrow of the building construction of our street architecture, that walls properly so-called, are now few, generally the normal pair of party structures only, the remainder consisting of panels of brick or stone material filled into the framings of metal work, while the floors themselves have, in all important premises, ceased to be of wood, and are of iron filled in with concrete or terra cotta. The main problem of all construction—that of the distribution and carrying of weights—is also most profoundly affected by steel construction. The sectional area required in the supports is so limited, and the spans of the bearing girders so great, that the traditional proportions based upon wooden beams and stone arches, which have become almost a second sense of mankind universal, have now ceased to be of any value. The change of this essential and fundamental factor of constructive proportion must reconstruct the visible expression and meaning of the symbols derived from the stone and wooden architecture of the past. These symbols exist in the mouldings, cornices, architraves, capitals, bases and detail of the architectural ordinances of the various so-called styles. The modern architect should emerge from his museum of palæolithic implements, and enter upon the iron age of commercial architecture with a good heart and reliant enterprise. The new factors of proportion are as valid as those that have passed away, and there is the same universal sense of what is just and true to ensure the appreciation of intellectual motive, and is not this itself the sense of the beautiful in architecture? The new "Half Steel" has exactly the same claim to be interesting first and beautiful afterwards, as its exact forerunner the "Half Timber," and it should be studied and applied upon the same principles of expressive characterisation of its constructive facts. The rivet heads, stiffeners and knees of framed girder and stanchion work are similar elements to the oak pegs, bracings and bracketings of our charming old English fronts. That has passed away, with the sweet forests of Robin Hood, this remains with the black country of the smelting furnace and coal mine, but is as real and more real to us, as true indeed and as noble in service if looked at straightly without the pseudo-mediæval squint of a false æstheticism.

Again the old English frontispieces are charming to us, because, may be, the glazing is all of little pieces connected together by leaden strips, and our modern English warehouses are disagreeable and inartistic, because the glazing is of the more suitable and perfect material of the plate-glass of modern discovery. This is an anachronism which illustrates the conflict between current artistic ideas and common sense that has had so malevolent an effect upon our business-house architecture.

The steel joist and stanchion not only have their principal use in the general internal construction of modern city buildings, but concern our subject mainly in their appearance, or perhaps we should say non-appearance, upon the street front. By their aid the shop window is enabled to extend itself across the whole site, an advantage the commercial man cannot be induced to sacrifice for any architectural fancy of the necessity of visible support for superstructure. It is of no matter to him what the architect does with the girder so long as he provides unhindered window space for the exhibition of wares. Its uses to the builder are very many, as it dispenses with arches, the thrusting weights of which are carried by it with certainty to the points of support; it receives the floor joists easily, and is so rapidly constructed and fixed that the poor architect has to be content and accept it. He, however, endeavours to satisfy his artistic conscience with delusions, by masking the objectionable girder in stonework and resigning all criticism of the lower storey, beginning his own conception above it. But the ironmonger dogs the artist's steps still, and in window lintels and supports asserts the value and economy of metal over stone and wood remorselessly; the wide windows high up to the ceiling and low down to the floor, perforce, must be spanned too by girders, as there is so little room for rising arches or other means of construction, and these girders again are covered over with more or less delicate stone mouldings attached and pinned to the iron frame in an indescribably unconstructive manner. Few architects have as yet had the courage to work out an iron architecture, say with glazed brick, terra cotta, stone, or concrete fillings. There have been stimulating experiments, but the mental effort of departure from the well-worn conventions of stonework design is apparently too great for the generality of street architecture practitioners.

Modernism in Design.

The architect may find some difficulty in adapting his taste to his sense, and his sentiments to business judgment, but ere long the sounder ideal of modern common sense in these matters will be found as enjoyable as that of an old England, which is at the best unreal and imitative, and however charming and possible in the circles of ecclesiastical and domestic art is inadmissible in the sphere of modern progressive commercial building. The meeting of architectural art and business life will not be found upon any ground of compromise between that which is ancient and modern, or between that which is ideal and practical, but in such a practical employment of modern conditions as will lead the way to further usefulness and appropriateness in building.

A whole-hearted acceptance of the doctrine of a frank modernism of design and construction in business premises by architects, is sufficient requirement to make of them for the establishment and growth in our midst of healthy street architecture, expressing the movement of the age in its requirements, and reflecting the intellectual attitude of trained and artistic minds applied to a commercial problem in building. The profitless and stupid antipathy that is supposed to exist between commercial requirements and artistic character, should thus, at all events in architecture, cease to be professed, and having reformed the attitude of art to business life we can the more sincerely and successfully hope for and attempt the resuscitation, for it once existed in pure and noble beauty, of living art in the commercial world.

The employment of modern materials and the joyful acceptance of current requirements as a means of expressing a progressive architecture will, however, bring the architect into conflict with other ideals than those merely of archæological correctness or of an antique style, as serious problems in design, nearly all as yet practically unsolved, await him. The first and upper floors have to be designed over and upon a lofty ground floor shop, the front part of which occupies all the clear space between the ends of the boundary or party walls on each side.

Now it may be taken as a canon of architecture that buildings must not only be of a construction that is secure in itself, but must be obviously so, for a building, however scientifically correct, will not be architecturally satisfactory to the eye and mind unless it also appears to be safe. Doubtless time is a great convincer in matters of artistic criticism, and if a sufficient number of examples of a novel method of construction were put before the world to manifest to it that what is apparently unsafe, perhaps hung upon nothing, is after all perfectly secure, and scientific besides, after a time this canon of architectural criticism would be satisfied, in spite of itself, by the relation of experience to judgment, and the disappearance of that distrust of novelty which is a gift of Providence to save men from calamitous experiments.

THE SHOP WINDOW.

We should therefore have become accustomed by this time to seeing great and massive erections of weighty stone and brickwork poised upon the slender brass pillarettes, lace-like arches, plate-glass fittings, and mahogany fascias of shop fronts, but we are, I am sure, suffering artistic discomfort and deriving no pleasure from their carved and ornamental blandishments, owing to the initial hiatus that the system of architectural design employed demands a basement and obvious foundation, and has none. With this difficulty the modern architect wrestles ineffectually; the implements of his trade were all made for buildings with bases, and he knows not how with them to fashion a modern design without obvious support. This difficulty is everywhere self-confessed, and has caused an infinity of interesting and sometimes amusing expedients. The projection of the shop front beyond the general face of the upper storeys of the front, thrown out so to speak as a screen beyond it, is a device only very partially successful; it has a certain sufficiency when the shutters are down, but modern progress is depriving the shop architect of this scrappy resource for architectural effect at close times, and on Bank and half-holidays. The void is there, gaping all the week, with perhaps the flimsiest draperies depending from the ceiling within it, dispelling all illusion as to supporting a very mine of weight overhead. The emphasising of the end piers which mask the party wall ends with the development of a cornice with the shop fascia connecting them to form a horizontal bridge, on which the upper part is carried, is frequent. This should be a more satisfactory method, as it would disregard the shop front and its contents, and dissociate the composition of the upper storeys from the lower ones. Failure however occurs in that the establishment by this treatment of a factor of architectural proportion integral to the whole front has as yet failed to obtain recognition. The architect supposes that his problem has been solved, and proceeds in designing the floors immediately over to dispose their proportions in the traditional way employing lintels and openings of ordinary narrowness, each of which is unconsciously engaged in defying the exaggerated yawn of the cavern below, which is spanned by an abnormal member of their own architectural family. It may be more easy to point out than to demonstrate that the system of proportion compelled by the ground storey should be recognised in the design of the upper ones, and though openings above are not required of the extent of that below, a logical symmetry of spacing would take the first factor, and by progressive reduction or systematic subdivision apply the scale and diminish the proportions harmoniously.

THE MEZZANINE.

We have referred to the usual treatment of the shop or ground-floor storey by supporting pilasters and a carrying cornice with a reversion to ordinary proportions in the upper part, but the treatment of the storey over the shop front as a mezzanine or *entresol*, and as part of the shop front, must be dealt with. A few years ago it was more commonly used, as an architectural device for getting over the difficulty of affording apparent support to the upper part, than it has been of late years; the latter developments of shop design have a tendency to make two storeys of shop fronts extend over an area of plate-glass unbroken by constructive lines, to the extent of about half the elevation of the building. The mezzanine proper was enclosed by an arch springing from the side pilasters at the level of the head of the shop front spanning the whole frontage, if of ordinary narrowness, it would rise to the underside of the floor over the mezzanine; thus an arch was gained of considerable size, and at first sight of some capacity, not only for carrying the upper storeys, but of blending the smaller scale of the upper part gradually and harmoniously with the ground floor.

For single house and shop fronts this method has not proved very successful. It can be easily imagined, and indeed seen in many examples readily called to mind, that a large arch springing from narrow pilasters on the extreme limits of a frontage gives the impression that its thrust must be acting upon the neighbouring buildings—in the most likely cases also shops, and crushing them. The initiated would, of course, understand that this does not actually happen, as the arch is more apparent than real, the weight of the upper building upon it being probably carried on a concealed horizontal girder behind the crown of the arch. The success of the arched mezzanine treatment therefore depends largely upon the neighbouring abutments, and unless these are controlled by the same designer or pre-exist in a satisfactory way, the experiment is very risky. Instances can be cited in very modern London of lofty and powerfully-drawn arches of brick and stonework carrying with apparently scientific and architectural balance a series of upper storeys, by conveying their weight with every optical demonstration of mechanical law against the plate-glass expanse of a neighbouring elevation of the picture-frame order.

The *entresol* arch is also dependent for complete effect upon a sufficient reveal or exposed thickness on its under sides to convey an impression of the substance requisite to arched construction of ordinary walling materials. This is difficult where the shop front is continued upwards into the mezzanine, but can be obtained by recessing the window of the mezzanine upon the shop fascia.

The arched mezzanine treatment is most satisfactory when several fronts can be treated and a continuous effect, as of an arcade, obtained, the arches over each shop corresponding and providing the effect of mutual resistance to thrust which is required. In such cases there is no reason why the arched construction should not suffice for carrying the wall above, provided that the easement of support required from the neighbouring houses is secured by the mutual covenants which originate in a joint ownership of such rights. The north side of New Oxford-street, towards its western end, affords a successful and satisfactory example of this treatment, the general proportions of the whole block and the reduced window requirements of the upper storeys being harmonised with the large openings of the ground and mezzanine storeys by the architectural treatment of the arcade. Though this example may be open to other criticisms as to internal arrangement, it presents a standard to which, unfortunately, there has been no approach in any more recent example of an extended façade of shop fronts. The architect should be urged to continue to study the use of the storey over the ground floor as a mezzanine on account of its value in extending the carrying proportions of the shop front, and of combining them with the complementary storeys of the building into a homogeneous and expressive design.

In general, architectural proportion is so much a matter of the relation of the solids to voids, that the designer of a shop-fronted house, limited as he is by earlier considerations, has very few principles left to guide him. The relationship of voids to solids cannot apply to this class of design, because the solids have to be eliminated as a condition precedent to suitability for shop display. The architecture becomes a collocation of window frames, and the solids of which these frames are apparently constructed are unreal concessions to architectural fancy, as in most cases the stone piers and window heads are but casings to metal girders and stanchions, large and small alike. Deprived of grouping, confined in perspective, tied to a topsy-turveydom of design, the architect of a shop front has difficulties to contend with which one devoutly hopes that he is alive to. But it is to be feared, that by the instructions of his commercial employer, his new front must be exactly like a superior rival's, or like the Louvre in Paris, or a Scotch castle, and he has steeled his artistic soul, reflecting that it is hopeless and profitless to struggle with a client who has no taste, and that after all he is not paid by him for any other purpose than to provide him with just what he knows he wants.

NAMES AND SIGNS.

I have not mentioned other artistic terrors, as figure or name tablets, signs, and electric startlers, in many cases necessary to commercial existence, though rendered so only by the force of a bad habit, which could be readily and painlessly cured by statutory enactment. It may be suggested to the commercial world that the streets of shops in London, are those where this obnoxious habit of self-assertive emptiness is less apparent than elsewhere, reputation and succ being assumed by the public to belong to that house of business that dispenses with—to put it mildly—inartistic advertisement. However, as part of that frank modernism which we have predicated for the commercial architect, the provision of significant spaces for inscriptions, and of such signs, as architecture can, by deliberate forethought pre-arrange and make properly conspicuous and artistic at once, is a certain part of the problem, and a by no means unpleasant one. Inscriptions and signs add a literary value to buildings which grows in value with every year of their history, and we could foresee a pleasant development of particular symbols and types in commercial architecture expressive of purpose in the building, of use alike to the tradesman, and of interest to the public and artist.

Horizontal and Vertical Principles of Design.

The architectural qualities which can be exhibited in street architecture are thus comparatively limited. In the greater number of cases the front or façade only can be seen and is capable of considered design, though in corner buildings there is a return frontage available which admits of some grouping. The fronts of the many buildings forming a street are each comparatively narrow and lofty, and, unless the street is a wide one, the general effect of the design can only be appreciated from the limited standpoint of the pavement, either in sharp approaching perspective or in a directly opposite view from a point near to and under the building. These limitations very seriously affect the possibilities of successful results, it being borne in mind that the success of the architecture is that of the executed building *in situ*, and not of the harmony of the proportions in true elevation or upon its picturesqueness in an ideal perspective view. The test of satisfactory result rather than of pleasing elevation must be applied rigorously to his work by the architect. This is not an easy thing to do, as each projection and horizontal effect is accentuated, while vertical lines and proportions are all foreshortened from either of the possible perspectives of an ordinary street. London architecture has but few examples of suitable methods of dealing with this difficulty. The horizontal cornice upon the skyline and similar lines subdividing the front above and below each storey of windows are the more usual methods. These have become simple to the designer solely from custom and from the facility with which they are drawn with a T-square, but a free consideration of the problem of designing narrow frontages to lofty buildings in a narrow street, would certainly suggest that horizontal lines, with no continuity beyond the limits of a small site are not the only means with which to attempt suitable design. The varying contours of streets, sometimes broken, curved, and crooked, sometimes in long straight lines, would direct some treatment which would not necessarily — as continuous horizontal lines must—throw each separate frontage into violent contact with the proportions of its neighbour.

There grew up in Gothic times, in the narrow, devious lanes of busy mediæval towns, a method quite as universal as the use of horizontal cornices and lines, in the use of vertical ones, in which the grouping and arrangement is upwards. Each window in a storey was grouped over the one below it, the margin lines being made continuous, and often carried up into a gable in which the centre one reached to the top creating storeys in the roof as it went up. This principle seems more natural and proper, and one can easily imagine its growth among the craftsmen as a necessary tradition of street building, vindicating itself by its suitability and truth of expression to their artistic instinct. It may be remarked, that in other branches of building, all of the same period, such as in the external design of churches, detached houses, and castles, there is no such universal tendency of vertical expression, the use of ornamental and corbelled parapets, tending to complete many aspects of these buildings horizontally. But in street architecture the vertical grouping is very general, and instances of any other principle would be difficult to find and group, until the dawn of the Renaissance, which brought with it the cult of the enormous horizontal crown or cornice.

Many examples remain in the low countries and in North and Western Germany, as at Lübeck, Münster in Westphalia, and Nuremberg, of the assiduous application of the vertical principal to narrow street fronts, executed in brick and stone, and collectively a more instructive exhibition of the innumerable possible combinations of simple forms upon one method is obtained. Of similar wooden architecture, where the horizontal principle of beam or lintel construction necessarily enters the construction and design, England furnishes examples in cities, such as Chester, Shrewsbury, and Tewkesbury, while in Normandy there are many refined examples of beautiful half-timber fronts. The application of a delicate artistic originality emphasizing and giving value to vertical expression can be observed in mediæval examples, and the employment of horizontal steps in the brickwork gables, so characteristic to us of Bruges, is echoed in stonework examples in Westphalia, while the Scotch corbie-stanes or crow's feet all subserve the same principle of design.

The advent of the Renaissance into Northern Europe did not, as in the South, bring the pedantic use of overhanging shadow-casting cornices into its less sunny clime, that was left for the pseudo Italian palaces which made the modern London of 50 years ago so gloomy, but allowed a great freedom of treatment in line and ornament, gradually casting loose from the craftsmen's methods of development from purpose by fitting and subduing all to preconceived notions of architectural effect. Swirling curves and disjointed architectural fixtures soon began to exercise themselves upon the polygon of wall surface provided by the front with its gable, and it was not until the need of a new restraint began to make itself felt that the freedom of rococo treatment was reduced by a steady application of horizontal cornice lines over and under each storey of the façade.

PICTURESQUE STREETS.

The happy independence which was obtained by each front, when the vertical method of design was practically universal, procured in the aggregate of a street view a charming grouping and freedom which has a fascinating effect, and always proves attractive to the artist follower of Prout and Roberts on his sketching tours. The more or less flexible curve of the lines of road and gutters in a winding narrow street combine and yet contrast with the closely grouped vertical subdivisions of the house fronts; broken by the occasional projection of oriels or corbelled turrets, or in half-timber work by joist ends and brackets. The gable peaks in varying proportions, heights, and skyline, naturally form themselves into pictures without effort of fancy or composition. The charm of a mediæval town has certainly within it a basis of reasonable beauty, instructive to us as modern street builders, which will bear stripping of its antiquity and associations. These are of the qualities with which we cannot endue our designs, and without them we should compare the artistic effect of more modern thoroughfares, whether purposely architectural—as in the chill sobriety of Moorgate or King William-streets—or accidentally arranged on modern lines—as in Queen Victoria-street or Shaftesbury-avenue with the earlier examples.

We do wish to assume a universal artistic principle of street building design, for to do so would be to limit the illimitable possibilities of artistic combination and effect, but from impressions of result we may derive safely enough the conclusion that in narrow frontages a design should be self-contained, its lines terminating satisfactorily within their own field, and the direction which is to the eye unbounded, namely, the vertical one, is that in which the artistic sense of appropriateness can be best brought to play. While totally, the effect of a street or city built of independent but self-contained designs is pleasing, the separate fronts adding together picturesquely in the necessarily horizontal sum of street perspective.

UNIFORMITY AND SYMMETRY, REGENT STREET.

There are, however, many principles of design and ideas of symmetrical or picturesque arrangement beside those into the discussion of which we have gone at some length.

The principal consideration, in contrast to what we will call the mediæval independence of each frontage, is that of a uniformity compulsorily applied, either by that relic of mediævalism, most necessary and useful to architectural effect, the lord of the manor, or by special legislation. The underlying idea in such cases is the almost unproved assumption that uniformity of effect in street architecture is necessary in the interests of dignity and art. This whole doctrine of architectural symmetry has been courageously assailed by Gothic revival enthusiasts, its value denied, and its effects of repetition and gradation scouted as formal weaknesses alien to the picturesque and truly artistic. The present generation stands in many respects at the parting of the ways. The heat of Gothic vigour has evaporated, and we are prepared to consider its artistic assertions at least as coolly as we have regarded the orders and proprieties of the preceding school which produced Regent-street and the park.

Within the last half-century public taste, national genius, or what you will to call that will o' the wisp, has romanticised into mediævalism with its guilds and crafts ideally uniting work with art in life, and not in vain; and also not in vain has it discovered the charms of the Bloomsbury and Soho view of art life, with its sober respectability of external appearance, and delicious completeness within, reticent to plainness about the house and home, and serenely Athenian in monumental churches and porticoed institutions. While this sprite of fashion is at present dissipating her enthusiasms in a somewhat libertine interlude, we can do no harm by putting in a plea for the organised hypocrisy of Regent-street, with its many and various dispositions and sub-divisions successfully masked in stately groups and blocks, culminating in the magnificent Quadrant, new made annually with fresh paint in every architectural feature with whiteness of surface — and is not architecture mainly surface matter after all! The sense of scale, of grouping, of harmony and of successful regulation, still survive in Regent-street, though well nigh three-quarters of a century have elapsed since it was designed, and of all London streets, it is yet the only one of which, as street architecture in total, we can in any way be proud. We must not fail, though, to qualify our self-congratulation by the objections which lie below the surface, for they will practically prevent an entire repetition of the experiment. The stately grouping of varying blocks has been achieved mainly by the sacrifice of what to-day would be altogether too valuable comfort in arrangement, and of market rental value in the "upper parts." There is a manifest wrestling between internal facts and external appearances, which struggles with windows, parapets and roof lines. The pleasant proportion of width of street to height of building will be rarely attained now in any great city, and the charm of curved line on which the whole street scheme is planned from St. James's-park to Langham-place is uniquely happy in its architectural effect. The effort was a great one; and the genius of Nash one for the occasion; the result is characteristic of the age that produced it, and serviceable and delightful to that which has followed. London would frankly approve of a repetition of the occasion, effort, and genius, and of a result as expressive of our generation as of that is of the "First Gentleman" of Europe.

SPECULATIVE BUILDING IN IMPORTANT STREETS.

A practical aspect of our subject sorely presses us to-day in London, and to some extent in all our larger cities. We have been considering the improvement of our street architecture upon definitions of the requirements of commercial buildings, and the way in which the architect seriously devoted to the advancement of his art can meet and give them artistic expression. These requirements postulate as a requirer, an intelligent progressive man of business, also a sympathetic and trained architectural mind to consider them. But practically neither the business man nor the architect have much to say upon the matter in a way which can affect street architecture, for buildings are now ready made for them. These are the production—and as such also express the characteristics and ideals of their producers—of building investors who buy or secure the most prominent and serviceable sites and erect speculative shops and warehouses upon them as ready for occupation by the purchaser. I do not propose to take any exception here to the speculative purchase of land likely to become valuable, or to its being offered at the highest obtainable figure, and though it is gravely open to doubt whether the policy of providing ready-made buildings is the best and most profitable either for the promoter or purchaser, or for both. But I conceive it well to be within the proper limits of our subject to-night to protest in the name of our commercial men, in the name of architects, and of all passers-by who have regard for the pleasant, decent and beautiful character of the cities of our land, against the great speculative building blocks recently erected, and now being carried out, upon many of the most important sites in the metropolis. The outrageous vulgarity of design, ignorance or defiance of elementary considerations of appropriateness of proportion, and of architectural suitability in expression, and the abominably bad ornamentation are surely an artistic scandal of a serious kind. There seems to be no protection for the public, refined or unrefined, against the insults to taste and national self-respect, which deface our finest and most important thoroughfares, through the sordid incapacity of grossly ignorant men. The architecture of the whole class of speculative building is normally of a low class, but since this element has invaded the more expensive sites and proceeded to erect buildings demanding the highest rents, the depths of the degradation of speculative building art have received a new exploration and exposure that is appalling. Kind nature makes us slowly oblivious to constant or recurrent physical pain, but, speaking from painful experience, I cannot discover any such alleviation in the doom of having to come into daily contact with buildings in high places exhibiting the worst effects of architectural degradation. Indeed, a settled despair of London, in spite of much in many directions to give bright hopes of oases of cheer in the desert, drops with chilling and deadly effect upon that zeal without which an architect is fairly useless to his fellows and his art. A really bad building is a upas tree, to be destroyed as rapidly as possible, and of the real badness of this branch of modern street architecture no one has any doubt. It is not even to be expected that the promoter, or even architect of such buildings possibly know or care that they are bad or good; their interests are otherwise entirely wrapt up in present profits; these are compelled; the buildings occupy certain positions, and ensure rents at no more or less, whether the architecture is a source of pleasure or pain to the citizens upon whom it is forced. We protest; if we can do nothing else, we will make this beginning, by crying revolt against a shamelessly bad architecture, a continued disgrace to our building art, commercial intelligence, national self-respect, and civilisation. There are no good points, not even of arrangement and suitability or of improvement, in the design of these blocks, while their construction sails as near disastrous inefficiency as the administration of a difficult statute by hardworked and heavily handicapped district surveyors can allow.

Regulation of Designs.

In conclusion it is not perhaps much good railing at a blot, however disfiguring upon the surface of a city, but as the mischief is spreading rapidly, we would point out again that, while not limiting free trade if you will, in land of public or private importance, there is a definite call for such a censorship, as liberal as you like, but cultured and wide, that will prevent the intrusion of ready-made or purposeless buildings of hideous and incompetent architecture as speculation upon our public streets. With good will some reference to authority of designs in important streets of distinctive character should be readily obtained. This at present exists by statute upon construction, height, purpose, and accommodation, but not upon the more widely-dispersed, though less realised evil, of bad design. There is as yet no sufficient standard of public taste to enable us to trust such censorship without fear of controversy in the hands of any mere officials, but having organised societies for the promotion of the fine arts and architecture, and for the improvement of our cities, there should be no difficulty in obtaining sufficiently large committees of taste willing to proffer advice, criticism, and to exercise veto without illiberality or narrowness. There may be danger in this suggestion, the censorship may prove either a stork or a log to the frogs, but there are greater dangers in the continuance of the existing state of things, for some of the best streets of London are already marred and appear to exhibit a gross decadence of public taste, which is really as untrue as any other artistic characteristic of such buildings.

The London County Council, happily, to some extent, seems alive to this danger in regard to the great thoroughfare which they have now in hand. It has proposed regulations for buildings upon the new crescent towards the Strand, and has held a tentative competition for uniform designs, that certainly marks a progression of ideas in the direction of proper control. But the subject is one of great difficulty and complexity; and unless the control is in the first place wisely directed, in the true interests of successful architecture, by highly competent hands, and in the second is so entirely firm by enactment and covenant that it cannot be broken away from, the experiment will not be successful. These two conditions are not unattainable, and Londoners hope for much, as they always do in spite of much disappointment. Into the discussion of the great new street from Holborn to the Strand, so full of detail and interest, we cannot now enter if we would. The preliminary work is too far advanced for suggestions to be of much value to the authorities, but we can and do appeal to all who build in our streets, whether promoters, owners, men of commerce, of speculation, or of public purpose, to employers, builders, and architects alike, to consider how deeply important is the right use of every opportunity of permanent building to the whole city, and if character is written in stone, wood, and iron, that character should reveal devotion to the highest ideals.

DISCUSSION.

The Chairman said that Mr. Pite's paper was very suggestive, and contained many new ideas. It dealt with subjects upon which many people had been afraid to venture. Perhaps street architecture was that form which interested people most, as one had to pass along the streets every day, and the buildings of streets either offended or pleased more than did buildings which one had to go out of one's way to see. The streets which interested us most were divisible into two classes, and were preserved in the memory as such, viz., the regular street, and the picturesque street, of which excellent examples had been shown on the screen. The picturesque street must be a matter of history. No one could build a picturesque street; if he attempted to do so he would fail, because picturesqueness depended so much upon the individuality with which the houses had been conceived. In streets like those of Hildesheim, and of many French towns, and of older towns in Italy, where every man built a house after his own fashion and to his own taste, there was a strong individuality which imparted to each house a character of its own, and made it a genuine work of art. But to build such a street straight off would be an impossibility. Such streets might be liked better by some than by others. The streets which he personally remembered with the greatest pleasure were those which had shown that individual character. It was easy to think of streets of which the variety of architecture was pleasing, but in which the buildings themselves were not very good. He thought that, until lately, there had been no more picturesque street in Europe than the Strand; yet in thinking of the buildings in that thoroughfare separately, there was scarcely a good one amongst them. As one looked along the Strand one had been able to get a grand idea of colour, and recess, and skyline, and glorious churches. That was an extremely delightful and picturesque street, which he feared would now only be a matter of memory. That was only possible as a result of a long order of events. When a new street was being laid down, as was being done into the Strand, a different set of conditions had to be faced. Picturesqueness and individuality were impossible, and therefore there must be some general scheme. That was the problem which had to be met in the re-building in progress in many parts of London. Those streets would consist chiefly of shops, than which there was nothing more ornamental, and to the man not in a hurry, nothing was more delightful than to gaze into them, and thus it was necessary to consider the great question which Mr. Pite had touched upon, namely, how to make shops architecturally good. To him, commercial architecture, if it was to be good at all, could only be so if it reflected the conditions of the age, and the purpose for which it was intended. What was it which our commercial architecture was to reflect? Should it reflect the commercial temper of the day? He feared the commercial temper of the present day could be summed up in the expression "shop front." The great object appeared to be to get as much space for the disply of goods as possible. One might say that modesty and reticence had almost left the commercial temper. The present was an age of advertisement and display, which pervaded us at every moment we came in contact with it. It was not possible to look out of the windows of the train without seeing the fields placarded with notices of soups and soaps and pills and plasters and ointments, and other quackeries of all kinds. One could not take up the newspaper without being decoyed into reading something, under the belief that it was intelligence, only to find it was an advertisement. Advertisement and self-assertion seemed to run through everything, and that was also expressed in the shop front of commercial architecture. It had come to stay, and could not be avoided, and therefore, as Mr. Pite had suggested, it was necessary to consider whether something could not be done to introduce art into the new condition of things. Whether that was possible, no one could say at present. At all events, one might be sure it would never be successful so long as attempts were made to build upstairs in the old fashion, and downstairs in the new. The result of that had been, that first and second floors of streets were of the same sort of solid construction as would have been built 100 years ago; but we had shaved off the lower storey, and now the greater part of London appeared to stand on the edge of sheets of plate-glass, with no visible means of support. He had always thought the real solution would be to confess the ironwork and allow it to be seen. The builders of the great sky-scraping edifices in America had lost a great chance in that way, for they had clothed them with a sham disguise of stone and brick, just as we had done with our Tower Bridge, which was a sham, the real bridge being inside what could be seen. If the Americans had grasped the opportunity and made their high buildings of real steel and iron construction which could be seen, they might have developed a new phase in art. In the matter of shop fronts he did not see why the pillars and girders of iron and steel should not be curved and shown, and filled in with brick, stone, and other materials, not in such a way as to disguise the anatomy of the building, but to form a protection against the weather. As the durability of iron depended on its covering of paint, it could be painted if exposed as he suggested; but much of the covered iron might become useless in 30 years. He felt certain Mr. Pite was on the right line when he said that our commercial architecture must be frankly modern. As to the faults of taste which now spoil it, he had never thought that could be met by regulation outside. Committees of taste would end in nothing but mediocrity. He did not know who would be put upon a committee of taste. He could hardly imagine any committee to which architects, as a body, would like to submit. People who had gone before such committees abroad, found that criticism was directed against anything which showed any approach to originality; the matter ended in compromise, and nothing was passed except what the committee could all agree upon, as offending none of them. He thought the real hope n the matter came not, in any respect, from outside, but from the improving of public taste itself. If people could once be got to believe that ornament was not necessary, and that expense was not beauty, there would be some hope for our architecture in the future.

Mr. H. LONGDEN thought the subject a very important one at the present time. There were some very beautiful street fronts in Bath, such as the Royal Crescent and the Circus by the Woods. But those were not streets of shops, and he confessed he had often looked at shops without being able to see how the upper part of the building could be made to harmonize with the lower, when the latter was practically all glass. If that were carried to another storey, and then another, there would be a kind of birdcage. He was not an architect, but the question seemed to him a difficult one to solve. There was also the question of fire to be thought of. He believed an iron structure was very untrustworthy in a case of fire. If the unspeakably hideous sky-scrapers in America had fires in them, he thought the stanchions and girders would twist, and the whole structure would come down. A building of brick and stone and good wood properly used would stand fire a great deal better. That was a very important matter which would have to be considered by architects.

Mr. MATTHEW WEBB said, as an artist, he had been very much interested in hearing Mr. Pite plead for sincerity and simplicity in the treatment of street architecture. Nature, in her structures, never consciously aimed at the beautiful, but strove for the useful, in all sincerity and simplicity. Much would come from that idea in the future, just as it had done in the past.

A vote of thanks to the reader of the paper was proposed by the CHAIRMAN, and carried unanimously.

Mr. BERESFORD PITE, in acknowledging the vote of thanks said that from the shop front to Nature was a far cry. How far we could be content with simple honesty of construction in a City which was felt to be deserving of the application of dignity and ornament to its streets was the point upon which difficulty arose. He hoped, in spite of the Chairman's caveat against committees of taste, the fact would come home to the public, that, however, much public taste might be educated, the bad buildings he had described were untrue in their representation of the age which produced them. However much the taste of the public—of the producer and the retailer—might be improved, it had been improved in vain owing to the action of the market or corner which had been created in commercial sites. The commercial site was bought in the public market, or in negotiation, by a speculator, who was not a producer, nor a warehouseman, nor a salesman, nor a purchaser. He had not the slightest interest in the matter, except putting a building on the site and disposing of it and the responsibility connected with it, at the best price he could get, and at the earliest possible moment. He did not think the plea was unreasonable that those who had to live amid such things and really face them, and pay rates in the City which such buildings marred, should demand that the law which stipulated —rightly or wrongly—as to the details of their construction, should also stipulate that the building itself must be more or less acceptable to the public sense. This stork might devour the frog, or the log might be deaf to entreaty, but Jupiter was required to intervene; and Jupiter in this case was public opinion. It was not so much public taste, as he believed that was already educated on the subject. As he had said, no one would controvert the fact that those speculative buildings were of bad architecture; and therefore, because the public was educated to that stage, it demanded their compulsory modification.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 23rd, 1902; RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., Director of the National Physical Laboratory, in the chair.

The following candidates were proposed for election as members of the Society:—

Puzey, Edmund Dunlop, Secunderabad, Deccan, India.
Earp, Francis Salsbury, Ph.D., F.I.C., F.C.S., Kalgoorlie, Western Australia.
Kilner, George William, Ravenscroft, Moss Hall Grove, North Finchley, N., and Great Northern Railway Goods Station, King's-cross, N.

The following members were balloted for, and duly elected members of the Society:—

Aburrow, Charles, M.Inst.C.E., F.G.S., Johannesburg, Transvaal, South Africa.
Carver, Thomas Albert Briggs, B.Sc., 118, Napiershall-street, Glasgow.
Chesney, Cummings C., Stanley Electric Manufacturing Company, Pittsfield, Massachusetts, U.S. America.
Davis, Brinton B., Paducah, Kentucky, U.S. America.
De Vinne, Theodore Low, 300, West 76th-street, New York, U.S. America.
Dodge, William Earl, 99, John-street, New York, U.S. America.
Dyer, Bertram L., Public Library, Kimberley, Griqualand West, South Africa.
Edington, Alexander, M.D., F.R.S.E., Colonial Bacteriological Institute, Graham's Town, Cape of Good Hope, South Africa.
Foo Choo Choon, Lahat, Kinta, Perak, Federated Malay States.
Fritchley, Edwin Wollaston, F.S.I., 6 Sirdar's Palace, Hummum-street, Fort, Bombay, India.
Greenhill, Thomas Arthur, Assoc.M.Inst.C.E., M.I.M.E., Santa Teresa, 9, Madrid.

Henderson, Joseph J., M.I.M.E., 689, Tenth-street, Brooklyn, New York, U.S. America.
Higgins, John, County Engineer, Greymouth, New Zealand.
Johnston, Augustus Fredric, Assistant Engineer, North Western Railway, Shikarpur, Sind, India.
Paine, Robert Treat, 6, Joy-street, Boston, Massachusetts, U.S. America.
Ridley, Hon. Matthew White, M.P., 36, Portland-place, W.
Sale, Charles V., Messrs. Sale and Co., Limited, No. 167, Yokohama, Japan.
Veeder, Major Albert, M.D., Broad-street and Queen-street, Lyons, Wayne County, New York, U.S. America.
Wales, Nathaniel Young Armstrong, Messrs. Mason and Wales, Dunedin, New Zealand.
Walker, David C., Gibbonsville, Idaho, U.S. America.
Walker, John Shaw, M.Am.Soc.C.E., Railway Department, Perth, West Australia.
Wilcken, A. F., care of Standard Bank of South Africa, 10, Clement's-lane, E.C.

The paper read was—

OPTO-TECHNICS.

By Silvanus P. Thompson, D.Sc., F.R.S.

Though we often hear of the magnitude and growth of the engineering industries, of the chemical industries, and of the electrical industries, we seldom hear of the optical industries, or of their importance in the national life. Few persons have probably ever considered what are the optical industries, how varied in character, and of what magnitude. Yet they are no inconsiderable part of those industries—using the word in its widest sense to include trading as well as manufacturing—which, like engineering and the chemical and electrical trades, are based upon science and scientific invention. According to the London Post Office Directory there are 216 firms described as "opticians," within the postal area, which excludes most of the suburbs. But, in addition, there are numerous other trades, amongst which are glass manufacturers, glass grinders, glass polishers, glass silverers, looking-glass makers, magic lantern makers, magic lantern slide makers, microscope makers, micrometer makers, optical turners, optical-case makers, opera-glass makers, photographic apparatus makers, photographic frame makers, photographic lamp makers, photographic lens makers, photographic material makers, photo-printers, photo-gravurists, photo-lithographers, spectacle makers, spectacle-case makers, spectacle lens makers, and telescope makers. This category does not include the makers of levels, theodolites and surveying instruments, or photographers and photographic artists, nor does it include the purely professional class of ophthalmic surgeons. If one were to include the employees of the optical shops and factories, the warehousemen, shopmen, assistants, foremen, fitters, clerks, and labourers, the total number of persons employed in the aggregate of the optical industries would be found to be very great. It is impossible to state it with even approximate accuracy. It cannot be less than 15,000 to 20,000 persons in the London district alone. What the number may be in Great Britain of simple opticians, or of opticians who combine the trades of jeweller and optician, or of pharmacist and optician, I do not know. But, merely classifying together those whose optical work consists chiefly in dealing with spectacles (many of them also trading in opera glasses, telescopes, microscopes, cameras, &c.), and including assistants brought up to the trade, the number of opticians in the trade must be at least 10,000 within the United Kingdom.

While it is true that many of these are mere traders, it cannot be too strongly stated that for all of them, unless employed as labourers, errand-boys, or simple attendants, a certain amount of optical knowledge is an absolute necessity. All those in particular who have to sell, supply, fit, or adapt spectacles to customers, must have a real working knowledge of the first principles of optics, of the properties of lenses, and of the optical functions and relations of the eye as an instrument. This implies a certain scientific training. In the case of the optical manufacturers and their employees, a further training in optical science is necessary; and for the masters and foremen of the optical factories, this training must be a highly specialized one, involving both theory and its technical applications. For them, above all, a technical training in optics is a prime necessity: and it must be thorough.

Having thus briefly glanced at the optical industries themselves, let us take a similar brief review of the science of optics which lies at the basis of all these industrial and commercial developments.

Optics, the science of light and its properties, is concerned in the first place with the laws of refraction and of reflexion—mainly with the former. The essential fact, both in the refraction and in the reflexion of light, is angular deviation. The light which was proceeding from some source, in some particular direction, is, when refracted or reflected, caused to proceed in some other direction at an angle with its former path. It is fundamental in this most elementary part of optics, to know the simple physical facts about the angles concerned in refraction and reflexion, and their relation to the surfaces at which the light is so refracted or reflected. The physical fact that in the act of refraction, ordinary light is dispersed into a series of coloured constituents, is also a fundamental point. Now refraction occurs whenever light passes from one optical medium to another, as when, for example, light passes from air into glass; and since different kinds of glass act differently from one another, any complete grasp of these simple, physical facts will involve some further knowledge. It will in fact necessitate a knowledge of optical glass: its varieties, their respective virtues and defects, their refractivity, their dispersivity for colours, the degree of rationality or irrationality of their dispersion. For technical purposes it is also needful to know how the various kinds of optical glass differ amongst themselves in density, hardness, and in liability to atmospheric deterioration.

Now to study but the first of these points, the refractivity of glass requires a certain amount of preliminary knowledge. For since the index of refraction is measured by, and defined as a ratio between, the trigonometrical sines of certain angles, its proper comprehension is only possible to those who have already comprehended what is the meaning of the sine of an angle. So there must be a basis of mathematical knowledge. Also in technical work it is vital that refraction should be studied by the use of the instrument appropriate for the exact measurement of angular deviations, namely, the "optical circle," also sometimes called the "spectrometer." Further, since the power of any lens or combination of lenses depends not only on the refractivity of the glass or glasses used in its construction, but on the curvatures of its surfaces, it is necessary as a preliminary to know and be familiar with the definition of "curvature"—a purely geometrical conception—and for technical purposes it is necessary to be acquainted with the proper instruments for measuring the curvatures of surfaces, the so-called "spherometers," and with the methods of using them and of working out the calculations appropriate to them.

We see then that as a necessary foundation for any sound technical knowledge of optics there are at least four things essential:—

(1). A knowledge of certain physical facts and laws relating to the angular deviations of the paths of light in being refracted or reflected.

(2). A knowledge of the varieties and properties of optical materials, particularly of optical glass.

(3). A knowledge of elementary mathematics up at least to the trigonometry of one angle, and a certain facility in using algebraic and trigonometrical formulæ in calculation, and in using mathematical tables.

(4). A working, personally acquired, knowledge of the instruments that are used in the optical measurement of angles, and in the measurement of curvatures of surfaces.

It would, perhaps, be more rational to put these four fundamental requirements in a different order.

(*a*). Mathematical knowledge and practice in calculating.

(*b*). Knowledge of the general physical properties of light, refraction, dispersion, reflection, &c.

(*c*). Practice in using, and comprehension of the principles of such optical measuring instruments as the spectrometer and the spherometer, also the focometer and other instruments.

(*d*). Knowledge as to the optical properties of glass of different kinds, and of a few other substances used in optical work—quartz, fluorspar, Canada balsam, water, cedar-wood oil, &c., acquired by observation with measuring instruments.

The first of these can be taught in the classroom, or less advantageously learned from books. The second can be taught and learned in like manner, but ought, from begining to end, to be studied by the aid of experiments. The third requires the use of instruments of precision, and is most appropriately followed in a properly-equipped optical laboratory. The fourth, provided the other three have been really learned, not crammed, nor skipped, may be acquired from tabulated recorded results of observation, accompanied preferably by reference to a set of specimens.

He who has been trained, or has trained himself, in these four elementary parts of optical science, will have acquired a knowledge of lenses, prisms, and mirrors, and of the dependence of their respective optical properties upon their geometrical shapes, and the material of which they are constructed.

"Matter" and "form"—the old battle-words of Aristotle and the schoolmen—both must be studied, because both are essentially concerned in the properties of any and every lens or prism. The formulæ for the power of any lens or prism, always in every case contain two factors, one depending purely on the physical properties of the glass, the other purely on its geometrical shape. Hence the fundamental necessity in optical study of *experiment* to supply the first, and of *mathematics* to express the second. But he who has mastered this bit of elementary optics, has yet much to learn.

Our eyes, being optical instruments, and instruments liable to many grave defects as well as to diseases, it is vital that the optician should acquire a sound knowledge of the optical properties of the eye, and of its defects as an optical instrument, even though he may never have to study its diseases, or be required to know anything about their treatment or cure. His first business with the eye is with its optical construction, its adjustments, and the use of spectacles to correct its optical defects. This study of the eye involves a little elementary anatomy and a little elemenmentary physiology; but more than either it involves a comparative study of the eye with other optical instruments: best of all a comparison with the camera, since the eye-ball is itself a camera of most exquisite construction, with lens in front, with automatic iris diaphragm, with automatic focussing by the aid of an auxiliary lens behind the diaphragm, and with a sensitive film at the back whereon the images are focussed. Every young optician ought to assist his own studies by getting a sheep's eye or a cow's eye to cut up with his own hands. If he rests content with looking at a book instead of making friends with the nearest butcher he throws away a chance. But every young optician will find that his knowledge of the eye will be woefully incomplete if he stops short here. Nothing will better help him to realise the defects of the eye than to study the defects of other optical instruments. A single common convex lens, the fatter the better, will provide him with a highly defective optical instrument. For he has yet to learn a new chapter in optics.

The study of the various aberrations of lenses will go a long way toward perfecting the training of an optician. He cannot study them without both experimenting and thinking. He will not understand them unless he has really grasped the more fundamental parts of optical theory. To understand aberrations he must perforce learn, if he does not already know, the bare essentials that have been already mentioned. And when he comes to study the defects of his lens by trying its optical performance on different objects, trying to get by its means sharp images of luminous objects such as bright points, bright lines, bright pictures, he will discover, or he may be taught, that the defects which the scientific men call aberrations fall into two classes—one depending on *material*, the other depending solely on *form*. He will learn that the defect which causes the image of a bright white point to be surrounded with coloured margins—which the learned call "chromatic aberration"—is due to the material—the glass—and its unequal refractive action on the differently coloured constituents of light. If he pursues the subject more deeply, he will discover that there are three different sorts of chromatic aberration, one affecting the position of the image, another affecting the size of the image, and a third, a residual one, which occurs when a second lens, made of a different kind of glass, is applied to reduce or correct the first sort. He will, in this way, be led to consider how an achromatic lens can be made out of two lenses; and if his teacher or his text-book is up to date, he will learn that there are two sorts of achromatic lenses, an old sort in which the two kinds of glass were a light crown and a dense flint; and a new sort in which there is a dense crown and a light flint. He will also learn that there is some advantage in combining three kinds of glass (or two kinds of glass with a third material, fluor-spar) to form a still more perfect *apochromatic lens*. When he turns to those defects which depend not on material but on form he will find a fine complication awaiting him. Prolonged studies of clever opticians in time past have enabled us to classify the aberrations due to the spherical curvatures of the lens-surfaces under five categories. There is *central aberration* preventing accurate focussing in the middle of the field; there is *coma* (or zonal aberration) causing blurred images at the margins. There is *radial astigmatism* making the images of points into little lines; there is *curvature of the image* preventing it from being all in focus at once on a flat screen, and lastly there is *distortion* of the image itself, causing straight lines to look curved. That makes eight defects in all, to which there must be added yet one more—the chromatic difference of the spherical aberration. And if he would go on to learn how these nine defects—three kinds of chromatic aberration, five kinds of spherical aberration, and one mixed sort—are to be cured in the design and construction of a camera lens, he will become an accomplished optician truly.

But long before he has mastered the theory of these aberrations he will necessarily have encountered a great deal of other optical information. He will have found a whole class of phenomena dependent upon the size of the light-waves. The *diffraction* phenomena which occur when light is sent through small apertures, will have been noted. He will have come across the colours of thin films due to the *interference* of light, the typical case of which is Newton's rings. He will have been led, therefore, to study interference. He will have learned the significance of the various orders of colours in Newton's rings. Possibly he may have had to acquaint himself with the investigations of Fresnel, and to study the wave theory in general. He ought to work with the *interferometer*, and measure wave lengths. Now that *diffraction gratings*, thanks to the labours of Nobert, Rayleigh, Rowland, and Thorpe, are to-day made in splendid perfection, and cheaply, he will have made observations on the diffraction spectrum, and will have compared it with the spectra produced by prisms of glass. In studying prismatic spectra he will have found that the lines of the spectrum are spaced out in different ways by different kinds of glass. All kinds of glass crowd up the red region of the spectrum as compared with the equable spacing observed in the diffraction spectrum, while some kinds of glass produce a relative crowding of the spectrum in the yellow and green regions more than other kinds of glass. This *irrationality* of the spectrum will naturally have prepared him to learn that there are some substances which produce a spectrum which is *anomalous* in having the colours in a different order—in which, for example, red light is refracted more than blue light, and in which red and blue are both refracted more than green.

Then he will also discover that there is another great class of beautiful phenomena which depend on the particular direction in which the light waves may be vibrating—the phenomena of *polarization* so-called, and he will have met with double-refraction.

Further, he will have been led to enquire into the laws governing the amount of light that is received from a given source at different distances, and those which govern the measurement of the brightness of lights. The subject of *photometry* will thus have come within his range of knowledge.

Finally, his attention will have been drawn to various *optical illusions*, and he will have had to consider sundry physiological properties of the eye, the *theory of colour-vision*, with its bearing on the tri-chromatic photography and three-colour printing, as well as the facts of *binocular vision* upon which the stereoscope is based.

Now, considering that every optician above the grade of a mere workman ought to know something of all these things, and that the competent optician must be master of a great many of them, the question arises how is his education to be carried out. How, and where, can he acquire all the varied scientific information with its experimental and mathematical basis?

In another branch of applied science—that of electrical engineering—a very similar problem is presented. How is the young electrician to learn the technics as well as the practice of his trade? Well, in that case, it has been recognized for twenty years that a proper systematic training is requisite, and provision has been made for it. In the factory, and in the drawing-office, as apprentice or pupil, he has to work at the constructive side, and learn by his own hands what electrical engineering is. But all over the country there are classes, schools, and technical colleges to which he can resort for instruction in the physical phenomena, for teaching in the theory, and for exercise in the application of the theory to practice. Electrical laboratories have been organized and equipped at great expense, that he may learn electrical measurement and electric testing, and verify for himself the known laws of electricity. In a word, the subject of *electrotechnics* is a recognized branch of education for the trade of electrician or electrical engineer.

But what is there to correspond for the education of the optician or optical engineer? Where are the classes in opto-technics? Let us see how far provision exists for those four elementary requirements which were laid down a few moments ago.

(*a*). The mathematics can be taught by the secondary schools; adequately taught, if only they will adopt sensible reforms in mathematical teaching and abandon the superstition that dragging a boy through the logical toils of a fossilized Euclid is the way of either teaching him geometry or of making him think.

(*b*). The physical facts and laws of elementary optics can be taught also by the secondary schools, or at least by those secondary schools which have proper provision for experiments in the lecture-room and in the laboratory. Very few, even of the organised science schools have, however, proper equipment for the experimental teaching of optics. It is taught as a branch of general physics or of the hybrid "subject," Sound-Heat-Light rolled into one; and seldom has the teacher himself had any training in practical optics. The ordinary science teacher is not in the habit of describing the powers of lenses in the international unit, the *dioptrie*. He is usually innocent of any knowledge of Gauss's method of treating lens problems. In short, his optical knowledge is largely circumscribed within the elementary university text-books of the last half century—books written by university dons for university students. Nevertheless, with proper experimental appliances, such lectures may serve a very useful purpose; and the future optician will be none the worse for elementary instruction in other branches of physics, including heat, acoustics, and electricity.

(*c*). Practice in optical measurement, with the use of the spherometer and of the optical circle as goniometer and spectrometer, together with practice in measuring focal lengths and the like, can only be acquired in an optical laboratory, or in the optical department of a physical laboratory. While so many of the secondary schools are well equipped for chemical and electrical teaching, it is a matter of extreme regret that so few of them are properly provided with optical appliances.

(*d*). Acquaintance with the varieties of optical glass, and with the few other transparent bodies used in optical constructions—quartz, Iceland-spar, fluor-spar, and Canada balsam—can readily be provided by a small collection of specimens in the museum of the science school. But specimens of optical glass and of spar cut to the shape of prisms for use in the laboratory ought also to be available.

If it be assumed that by a small improvement in the optical equipment of the science schools throughout the country and in the optical information of the science teachers, the above requirements should be fulfilled, then a suitable foundation will be available. But what more is required than this for the teaching of the future optician? Obviously there remains a considerable technical field over which even the ordinary optician must extend his mastery. He has yet to acquire much specialised knowledge in relation to spectacles and to instruments. He has yet to study the optical properties of the eye. He will have to master such technical matters as the properties of cylinder-lenses, the properties of sphero-cylinders, the transpositions of lenses, the properties of the combinations of prisms and lenses, the effects of decentering, all the mysteries of spectacle fitting, and many an other technicality of the spectacle trade. All that part he will learn, if he is diligent, in the trade itself, provided the scientific foundation has been properly laid. But if he would make rapid progress even in spectacle technics he must study—and this time not Cambridge text-books, but handbooks written by opticians for opticians.

But if this course of training suits the average optician in trade what about the further requirements in the scientific and technical training of the optical manufacturer? For him a much further and more specialized course of instruction is needed. He must not only be able to to grind and polish a lens, but to know how to compute it. Where is he to learn these things? The optical factory will train him in the practical part; but divorced from theory that training will leave him merely a skilled workman. He will have in the factory to use proof-glasses with their exquisite optical test, by the coloured interference rings and bands, of the perfection of the surfaces. The study of interference, diffraction, polarization, secondary spectrum, absorption coefficients, aberrations, — all these things which enter into his daily work ought to be at his finger ends. Where is he to acquire these higher studies in optics? There are books, but how sadly inefficient are even the best books to teach, if the instrumental appliances are not at hand. There are lectures in higher optics at the universities: but it is obvious that few of these who are going to enter optical factories can attend the university. Even if they did, they would find university lectures in optics sadly unreal—beautiful, but inefficient for their purpose. Where, then, can the needed training in advanced optical studies be obtained?

This query brings me to the main point of the present paper. I suggest as the proper solution the creation of a special technical college, an *Optotechnical Institute,* devoted the interests of optical science. It would e the counterpart of those colleges, or departents of colleges, devoted to electrical eng- eering, to which allusion has already been ade. This suggestion, which presently I ill further explain, does not, however, stand lone. No such educational step is successful ithout proper preparation of the way. Before ny such institute can be carried on with uccess, much must be done outside; and xisting means of preliminary education must be uch more fully utilised before such an institute an discharge its proper functions. Every oung optician ought now to be preparing for he work of his life by studying mathematics, geometrical drawing, and physics in the econdary schools and the science schools which exist under the Board of Education. Or if he has satisfactorily followed such preliminary work, he ought to be studying in special optical classes organised in the technical schools and colleges. Unfortunately, very few such technical schools or colleges have made preparation to hold special optical classes. Even in the larger municipal technical schools, and in the local university colleges, the equipment for teaching optics is very deficient—far in arrear of that provided for the teaching of electricity, or chemistry, or heat. Perhaps the answer of the managers of such schools or technical colleges to such a criticism is that the demand, down to the present, for direct teaching in optics is not such as to warrant them in spending money on the equipment, or in engaging teachers in optics who are possessed of the special qualifications. To teach chemistry or electrical engineering they engage special teachers trained up to their respective professions; and for them they provide apparatus and laboratories. Then why not for optics? One reason is that under the present educational system, or want of system, only those subjects are pushed and fostered which "pay" from the examination point of view. The examination curse, here as everywhere, warps and blights the educational growth.

What, for example, has South Kensington done in the past for the teaching of optics? It has of course included optics amongst the branches of physics taught in the Royal College of Science. As a former student of the Royal College of Science, I, for one, can never be too grateful for the teaching in experimental optics there given as a part of the physics course. But it has never entrusted the subject to a special lecturer in optics. It has a special professor of metallurgy and another of astronomical physics, but none of optics as such. It has further included "light," along with sound and heat, as a part of Subject VIII., amongst the subjects for the May examinations. For the past thirty years therefore, sound, light and heat have been taught together, all over the country, in science classes, for the elementary, advanced and honours stages. So far, so good. But has this met the need for the teaching of young opticians? Let the men in the optical trades answer.

By the kindness of Sir William Abney, the principal assistant-secretary of the Board of Education, I am able to give here the statistics of the classes held during the last ten years in this triple subject of Sound, Heat and Light, and of the subject of Light in the advanced and honours stages. Originally, the triple subject used to be kept up into the honours stage as a triple subject. This, however, was altered, partly, I believe, in consequence of some strictures of mine, a year or two before the period under consideration.

From the figures of Table I., it would appear that the number of candidates in the elementary (triple subject) stage, has decreased from 5,162 in 1892, to 949 in 1901. The number who passed has decreased from 3,939 in 1892, to 649 in 1901. It must be remembered that these numbers do not include candidates in training colleges. In the single subject of Light, the number of candidates in 1892, in the advanced and honours stages taken together was 418, of whom 264 passed. In 1901, the number of candidates was 299, of whom 199 passed. Judged by these statistics it would appear that there is a serious diminution in candidates in the advanced study of Light, and a startling diminution in the number of candidates in the elementary stage of Sound, Heat and Light.

In Table II. we have the statistics, not of examinations, but of classes and students. From these it would appear also, that the number of students in attendance dropped from 7,430 in 1892, to 4,596 in 1899, in the elementary subject, while in the advanced subject of Light the numbers dropped from 721 in 1892-3 to 251 in 1899. Nor is this the worst feature, for the numbers of classes held in different centres also dropped from 251 to 173 in the elementary (triple) subject, and from 65 to 22 in the single subject of Light; and has dropped to about 20 in the present year. I do not mention these statistical facts to blame

TABLE I.—Table giving Details of the Successes, &c., in the Subjects of Soun Light, and Heat, and of Light (advanced), at the Annual Science Examination (Board of Education), 1892-1901. (Exclusive of Training Colleges.)

Year.	Honours.				Advanced Stage.				Elementary Stage.			
	1st Class.	2nd Class.	Failures	Total.	1st Class.	2nd Class.	Failures	Total.	1st Class.	2nd Class.	Failures	Tota
1892.												
Sound, Light, and Heat (Elementary)	...	...	...	...	...	...	...	...	1,545	2,394	1,223	5,16
VIII*b*. Light	4	2	16	22	71	187	138	396	...	...	...	...
1893.									Under old Rules.			
									36	239	143	411
									Passes.		Failures	Total
Sound, Light, and Heat (Elementary)	...	...	...	...	...	...	...	...	943	...	2,831	3,774
VIII*b*. Light	1	6	18	25	59	174	233	466	...	...	...	...
1894.									Passes.	Fair.	Failures	Total
Sound, Light, and Heat (Elementary)	...	...	...	...	...	...	...	...	962	1,569	1,110	3,641
VIII*b*. Light	6	11	13	30	52	159	178	389	...	...	...	...
1895.												
Sound, Light, and Heat (Elementary)	...	...	...	...	...	...	...	...	1,207	1,318	1,522	4,047
VIII*b*. Light	2	9	25	36	49	146	204	399	...	...	...	...
1896.												
Sound, Light, and Heat (Elementary)	...	...	...	...	...	...	...	...	962	570	642	2,174
VIII*b*. Light	4	9	26	39	78	137	102	317	...	...	...	...
1897.												
Sound, Light, and Heat	...	...	...	...	...	...	...	...	857	677	1,047	2,581
VIII*b*. Light	2	3	18	23	38	118	90	246	...	...	...	...

	Honours (divided).														
	Part II.				Part I.										
	1st Class.	2nd Class.	Failures.	Total.	Passes.	Failures.	Total.								
1898.															
Sound, Light, and Heat	...	...	...	...	...	...	...	...	...	...	...	520	663	903	2,086
VIII*b*. Light	...	...	...	...	6	18	24	43	113	107	263	...	...	...	...
1899.															
Sound, Light, and Heat	...	...	...	...	...	...	...	...	...	...	...	529	624	1,064	2,217
VIII*b*. Light	...	1	...	1	4	14	18	71	155	86	312	...	...	...	...
1900.															
Sound, Light, and Heat	...	...	...	...	...	...	...	...	...	...	...	414	574	1,124	2,112
VIII*b*. Light	1	...	...	1	23	17	40	15	103	153	271	...	..	...	...
1901.															
Sound, Light, and Heat	...	...	...	...	...	...	...	...	...	...	...	305	344	300	949
VIII*b*. Light	...	1	1	2	2	7	9	51	145	92	288	...	...	...	...

e South Kensington administration. Surely there is one man competent to understand hat technical knowledge in optics means, at man is Sir William Abney. Furthermore, e years of this decrease are precisely those uring which the control over, and maintennce of, these science classes has passed from e control of South Kensington to that of the cal municipal bodies, or their technical ducation boards.

ABLE II.—Number of Classes and Students under Instruction in Sound, Light, and Heat (exclusive of Training Colleges).

Session	Subject VIII. Sound, Light, and Heat. (Elementary Stage.)		Subject VIII. *b.* Light. (Advanced Stage and Honours.)	
	Classes.	Students.	Classes.	Students.
1891–1892..	251	7,430	†	—
1892–1893..	282	6,602	65	721
1893–1894..	264	6,635	70	893
1894–1895..	263	7,186	56	834
1895–1896..	240	5,881	41	578
1896–1897..	241	5,425	47	680
1897–1898..	210	5,636	32	363
*1898–1899..	173	4,596	22	251
‡1899–1900	—	—	—	—
‡1900–1901				

* The figures for this Session are exclusive of those for Scotland.

† These classes are in addition to those held in Schools of Science since 1896. The number of these classes rose from 1896, from about 20 to 220 this year (1902), so that in the year 1898 at least 180 classes in all were held on "Light." The total number this year is probably about 250 respectively.

‡ The figures for these two Sessions are not available.

What is the meaning of this reduction? If in 1892 there were 65 classes in advanced light being held in the United Kingdom, why should that number now have fallen to 20? Are there fewer persons desiring instruction in optics now than in 1892? Is less money being spent on science teaching now than in 1892? The very question is absurd. Think of all the technical education grants out of the beer-money now at the disposal of the County Councils; of all the new technical institutes that have been opened; of the new physics laboratories that have been equipped. No; the cause must be sought for elsewhere. In spite of the great revival in experimental optics since 1896, in spite of the immense spread of popular photography, and all the incentives to study optics that have resulted from the forward movement in the optical trades now in full, we have a diminution of classes, of students, of candidates steadily going on. Is not the inference obvious that these classes on "Light," and on "Sound, Heat, and Light" (where light comes in only third!) do not meet the wants of real students of optics; do not suffice to afford to the young men in the optical industry the training they need, and are, therefore, not attended by such men.

I say unhesitatingly, that until the classes in optics are taught by men who have had optical experience, and who teach from a technical instead of an academic standpoint, the decrease here noted is bound to continue.

I specially appeal to the managers, principals, and committees of the local technical schools and colleges on this point. Do opticians attend their classes on Light? If not, why not? Has the teacher in charge of the class himself any knowledge of the technics of optics? If not, why was he put there in a false position? A technical subject demands a technically-trained man.

Further, I appeal for the creation of proper optical laboratories in the science schools, that the teacher may have a fair chance of training his students.

Perhaps you will say to me why make these criticisms and this appeal before setting your own house in order. The City and Guilds of London Institute for technical education took the lead twenty years ago. It built the first two technical colleges—the oldest one at Finsbury, and the largest and best equipped one at Kensington. It, from the first, made large and generous provision for the teaching of *electro-technics*, why has it not made provision for *opto-technics* also? There are certain reasons why these things have not been done, but for these I disclaim all responsibility. So far back as 1886, I made a formal proposition to establish, under the City and Guilds' Institute, an optical laboratory, which was indeed to be opto-technical, since it was to be equipped, not only with optical measuring instruments such as I have mentioned above, for the optical testing of prisms, lenses, plane-surfaces, and optical instruments, but also with experimental optical tools for grinding and polishing. The suggestion was considered, and put aside for reasons doubtless sufficient to the governing body of that date, the main reason being that the building at Finsbury was already acknowledged to be two small for the purposes of chemistry, engineering and electro-technics for which it was built. Two years later, when the

Charity Commissioners were considering the establishment of educational institutes out of the funds of the City Parochial Charities, I renewed my suggestion. I sent to the Commissoners a proposition to found in London, preferably in Clerkenwell, an optical institute, specialised for the optical industries, and with laboratory equipment as before. My idea was that this should perform for the optical industries the same kind of function as the electro-technical laboratories at Finsbury were performing for the electrical industries in London. Again my proposals were put aside. The Commissioners were at that time strongly holden by what I hope I may without offence call polytechnic fever. Their one idea was that all these institutes (except the City of London College) should be made as mixed as possible, recreation and miscellaneous, non-literary instruction being organised in all without distinction. In vain did I point to the unwisdom of this course, and to the preferable course of concentrating the technical teaching in special centres of industry, instead of teaching everywhere smatterings of everything. Instead of *Polytechnics* I wished to see *Monotechnics;* for engineering at Battersea; for building trades in Islington; for printing trades in Fleet-street; for plumbing and tanning in Bermondsey; and for optics in Clerkenwell. I was not listened to; and the polytechnic idea prevailed. I had the honour of reading a paper on this topic in this very room on June 17th, 1897, when I expounded the monotechnic idea. Since that date, much has happened. The beer-money added to the funds of the City Parochial Charities has enabled the Technical Education Board of the London County Council to build their twelve Polytechnics, with the work of which you are familiar. That work, admirable as it is in so many ways, has, I am convinced, not been of one-half the value it would have been to the community had these Institutes been organised on a more rational plan. Of all of them the one which has been, so far as I am able to judge, the most successful is that in Bolt-court, Fleet-street, which differs from all the others in being a monotechnic for the printing trades. Can any other one show an equal influence on any trade? I do not forget how the Borough-road Polytechnic has specialised itself in tanning, in connection with the Herold's foundation, nor how engineering has been developed in Battersea; nor least of all do I overlook the circumstance that the Northampton Institute in Clerkenwell has now for some years considerably specialise its work and has organised *inter ali* an admirable course of teaching in rea optics, and equipped a laboratory ther for. It has indeed gone some way towar realising my suggestion for the creation of a Optotechnical Institute. The value of its wor is not yet half appreciated; every year will se its reputation increase. Success in each these cases has resulted from concentration effort on a definite technical aim. In fact, is not too much to say of the London poly technics, that the less they have had of *pol* and the more of *technic*, just so far have the benefited the industries.

But while these numerous technical institute have been growing up in the provinces, as we as in London, another movement has arisen The opticians themselves have begun t organise themselves in three separate ways fo the improvement of the scientific qualification of their own trade. In historic order these ar as follows: (1) Examination and certificatio of opticians by the British Optical Association (2) examination and certification of opticians by the ancient guild known as the Spectacl Makers' Company; (3) the foundation o the Optical Society. As I have had th honour of being associated from the firs with the Spectacle Makers' Company, I wil merely say that its aim has been to stimulate opticians to acquire proficiency in th technics of their craft by offering a diplom and fellowship in the company to those wh succeed in passing their examinations. Th subjects comprised are elementary mathematics, general elementary knowledge about light and heat, simple geometrical optics, mainly with application to lens problems and to the eye as an optical instrument, errors in the refraction of the eye and the use of spectacles, spectacle fitting, together with a proficiency in some special branch, such as microscope, camera, optical lantern, or sextant, &c. For masters and assistants of many years standing a modified examination that does not include mathematics nor special instruments has been adopted. During the four years that this examination system has been at work 318 such diplomas in optics have been granted by the Company on examination, in addition to 46 honorary diplomas issued by agreement to certain others who had previously been examined by the British Optical Association. Four years' experience with the examinations of the Spectacle Makers' Company has shown me that while the stimulus of the work has been of eat benefit in the optical trades in inciting the unger members to read up some of the princi- es of optics, yet the organisation for the ining in laboratory and class-room of these ung opticians, is very unsatisfactory. To v of the candidates—and they come not only m London, but from all principal towns— es it seem ever to have occurred even to quire whether mathematics and optics were ught at the nearest technical school or science hool. Of the London candidates, hardly any me from any of the technical institutes, the orthampton Institute being the one exception. any of them seem to think that six months' am ought to provide all that they require in e way of preparation, their knowledge of theo- tical and experimental optics being in many ses of no longer date. Of course, amongst ch candidates there is much disappointment, d happily there are good candidates as well bad. But the good candidates are often lf-taught or privately taught, and owe little nothing to any public educational institution: e science schools and the municipal technical hools have not been of the slightest help to em. It is for the leaders in the optical dustries to enquire why the great expenditure money on technical education does little or thing to benefit them, or why the youuger en in the industry do not avail themselves that which exists. The optical industries Germany have profited enormously by e scientific training, in endowed laboratories physics, of the men who are now the eads of departments, and managers of their ptical factories. Think only of the advanced ate of certain branches of optics in Germany vealed by that most remarkable catalogue of e collective exhibit at the Paris Exhibition the opticians and instrument makers of ermany. Not that we are to take German ethods and copy them. England has to ork out its own problem in its own way; but t present, save for the classes at the North- mpton Institute, its educational systems are ot being used to help the opticians.

This brings me back to the vital suggestion f my paper, the creation—whether at the orthampton Institute in Clerkenwell, or else- here—of a real *Optotechnical Institute*. It ill need buildings, equipments, a staff, and an dequate income for maintenance. I think its urriculum ought to be somewhat as follows :—

(*a*). *Entrance Examinations.*—Computa- on (including logarithms, slide-rule, and use f trigonometric tables), Geometrical Drawing, erman.

(*b*). *First Year.* — Physics, Mechanics, Algebra and Trigonometry, Projective Geometry, Drawing, Laboratory work in simple Optics, with lens grinding and prism grinding. —*Certificate of Preliminary Studies.*

(*c*). *Second Year.*—Calculus, Higher Optics (including aberrations), Mechanical Drawing of Optical Instruments, Machine Design as applied to Instruments, Laboratory Measurements.—*Certificate of Further Studies.*

(*d*). *Advanced Course.*—Applications of Calculus, Higher Geometry, Theoretical Optics, Computation of Lenses, Optical Design, Higher Optical Measurements, and Optical Research. —*Honours Certificate.*

The staff ought to be picked men, who have liberty to practise as consulting opticians, that is to say, as consulting optical engineers. The aim ought to be to attract a few really good students rather than a crowd of mediocre ones. Every facility ought to be given for a student who can only afford a year's course as a day-student to continue his training in the evening, the laboratories being opened certain evenings during the week. The institute ought to make a speciality of having a perfect optical library, with collections of models and of detailed drawings. Finally the members of the staff ought to be encouraged to write optical monographs on some consistent plan, to replace the academic text-books of the past. It ought also to bring out a respectable optical journal with technical papers in optics well illustrated, not interlarded with trade advertisements, feeble jokes, or silly personal recriminations.

Not one of our poor optical journals can be named in the same breath as the *Zeitschrift für Instrumentenkunde.* In the English language we have no technical books to set beside the *Handbuch der Angewandten Optik* of Steinheil and Voit, or the *Theorie der Optischen Instrumente* of Czapski.

Scientific books, elementary and advanced, written by opticians for opticians are, for the moment, the thing most urgently needed for the furtherance of opto-technics.

DISCUSSION.

The CHAIRMAN, after expressing his regret at the absence of Sir William Abney, who was to have taken the chair, said he was one of the guilty university dons who had perpetrated one if not two of the scholastic text-books referred to by the author. He pleaded guilty to great ignorance on the subject brought forward until a short time ago when he was

asked to take part in a discussion on optical glass at the British Association, after which the Council of this Society had asked him to give a course of Cantor lectures. That led him to look into the question more completely, and he then found out its immense importance and how much Englishmen ought to study it. The ideas set forth by the reader of the paper were somewhat high, but not too high. It was absolutely necessary that they should be prepared to apply to any technics the very highest science and the most advanced mathematics. In speaking of such a subject it was difficult to avoid making reference to what had been done in Germany. It was absurd to suggest that the English workman was in any way inferior to his German brother, or that the English optician was at all behind the German optician, especially when one recognised the splendid work which had been and was being done by great English firms in optical matters. Yet be believed Mr. Dallmeyer would be the first to recognise that his beautiful astigmatic lens would not have been what it was without German glass, and he also believed Mr. Taylor would recognise that it would have been impossible for him to make his splendid lens without some of the German phosphate glasses. From a list which he saw a few days ago he was glad to know that Messrs. Chance were now able to supply to the English trade some at any rate of the same glasses, and he hoped in a short time that they would be in a position to supply still more. What had led to the great development of the optical glass making trade in Germany? Twenty years ago the manufacture of optical glass was almost entirely in the hands of English and French firms; the collection of German glasses exhibited by the author showed how far that statement was from the truth at the present moment. Dr. Thompson had referred to the fact that in 1898 Germany, which only began to make optical glass about 1881 or 1882, exported in the one year £30,000 worth of raw optical glass, £150,000 of worked optical glass for telescopes, and £70,000 worth of telescopes, field-glasses, and opera-glasses, &c., complete. What had led to that development? It seemed to him that Germany had recognised more than England had done up to the present the great value and importance of science as a commercial factor. Dr. Thompson had referred to that wonderful catalogue of German exhibits of glass at the Paris Exhibition. He also would refer to the preface of this catalogue, where, after a statement of some of the history of the past, it was written :—" Soon also the necessity was recognised of the close co-operation of the scientists and practical men. Accordingly, in 1879, several scientists, mechanicians, and opticians united in Berlin, and formed the nucleus of the German Association of Mechanicians and Opticians, which was formed in 1881, and embraced the whole German Empire, having for its object the scientific, technical, and con
mercial development of philosophical instrume
making. The official organ of this society, tl
Zeitschrift für Instrumentenkunde, was likewi
founded in 1881, and is devoted to the theoretic
and practical development of scientific instrumen
Specialized schools were established, first in Berli
then in Frankfort-on-the-Main, and subsequently
many other towns, where savants and practical m
combined in training the rising generation in t
theoretical departments of the subject. As a res
of these serious scientific aims, German mechanicia
and opticians sought in their laboratories a
workshops the assistance of scientists, and
the present time the majority of the leadi
German firms retain one or more experienc
mathematicians or physicists in their permane
service." That was the development of t
idea brought forward by Dr. Thompson, the est
lishment in England of an Optotechnical Institu
One other quotation from the catalogue at the prese
moment had special interest to himself, viz., "T
greatest share of the impetus given to the manufact
of scientific insruments, however, is due to the I
perial Physical and Technical Institute, which w
established in 1887. The first, or scientific, depa
ment of this important institution is devoted to pur
physical research, while the second, or technical,
partment deals with matters concerning the constr
tion of philosophical instrumeuts. This instituti
has already done great service, and a large prop
tion of recent progress is due to its stimulating a
helpful influence." For himself, and for the Natio
Physical Laboratory, of which he was the Direct
he wished to say that it was their aim to do for t
English trade, and for English opticians, what h
been done in the past twenty years by the Reichsta
in assisting the furtherance of German optical man
facture and trade; and if ten or fifteen years hence
could be said of the National Physical Laborato
that a large proportion of the advance which
hoped would be made in the English instrume
making trade was due to them, it would real
the aims of its founders and those who were r
ponsible for its being.

Professor CAREY FOSTER, F.R.S., as one of the u
less teachers who had been more or less referred to
Dr. Thompson, said that, many years ago, when he w
engaged in teaching such optics as he knew, he
that he was merely scratching the surface of the s
ject, and that for it to be of real importance to a
one who wished to apply the knowledge for practi
purposes, a very great deal more was necessary in
way of education. If the effect of the paper was
give a stimulus to a more thorough and techni
teaching of the subject than was available at prese
it would serve an extremely useful purpose.

Mr. T. R. DALLMEYER wished to emphasize
Chairman's remarks dealing with the question

arch entering into the manufacture of new glasses.
th regard to the theoretical side of the subject manu-
urers for many years had deplored the fact that
y were so behindhand in their works in manufactur-
photographic lenses. The profession was greatly
bted to the author for having recently made a
slation of Professor Lummer's work. He hoped the
hor might find time one day to translate the work
rofessor Czapski which, he believed, was the best
ressed work on photographic optics that had
erto been written. As an old pupil of Professor
ey Foster he would always look back with great
titude to his work in the laboratory at University
lege. The chief thing required at present was
t the results of the theoretical study of any subject
uld be recognised. Investigators in this country
e placed at a great disadvantage, owing to the
lts of their labours not finding recognition. The
stry owed a deep debt of gratitude to Messrs.
ott and Company for the work they compassed
er the German Government, in connection with
cal glass. With the exception of Sir George
kes's valuable work, the only work on photographic
es which had rendered any assistance to opticians,
that of Dr. Hopkinson, who was the first to work
a glass known as an extra light flint. It was
ainly due to the laboratory work originally con-
ted by the Germans, that English firms were at
sent able to carry out astigmatic corrections
ch were hitherto unattainable with the older forms
lass.

eneral J. Waterhouse hoped the recommen-
ons made by the author would be carried
effect. There could be no doubt there
a great want in the country not merely
text-book education but of actual practical
nical education. Having again to go into
subject a short time ago he experienced
great difficulty in obtaining an intelligent
mary of the subject from any English text-
k, but he at last obtained the information he
ght in Professor Lummer's work which had been
slated by the author. In connection with photo-
phic work, for many years he had had to trust
ost entirely to French and German text-books,
ng to the English books being so deficient in
rmation.

Ir. Conrad Beck, on behalf of the opticians,
ressed their warm thanks to the author for taking up
subject. A great deal had often been said of the
ances recently made by optical firms in Germany,
with great truth. He did not think that in all
s the fault in England had been on the side of
opticians, because from practical experience he
w that if one had not a knowledge of German,
as almost impossible to obtain optical information
ngland, which was of the slightest use in manu-
uring lenses. Whereas the English had been extremely prominent in work connected with physical optics they had of recent years fallen extremely behind in geometrical optics compared with other countries. The problem presented itself with considerable force to him a few years back in reference to his own assistants whom he was anxious should receive optical education. After trying various institutions he found that no optical education of any service was to be obtained, and, therefore, he started some classes on his own account. It was impossible to suppose that that was a satisfactory method of teaching optics, because of necessity it involved time which could only be spared from other occupations. Whereas for the last 40 or 50 years German text-books had had all the elementary optical problems worked out in a perfectly reasonable method on the Gauss system by which a student with no further knowledge than a slight acquaintance with trigonometry could work through for himself all the problems connected with the elementary uses, and, to some extent the manufacture of optical instruments, there were no English elementary text-book on geometrical optics. In dealing with the higher portions of the subject, the only books dealing with the question were written as far back as 1829. It had often been a wonder to him why no applied optics had been studied in England for the last 60 or 70 years. He could only suppose it was due to the fact that the study of physical optics was of so much greater interest to the mathematician that the other side became tame and uninteresting. The suggestion Dr. Thompson had made as to the starting of a school of optics could not fail to have the desired end, because excellent mathematicians would be employed who would devote their time solely to optics. One of the first things that could be done with very great advantage would be the issuing of two or three text-books on geometrical optics, compiled from the study of European literature on the subject, for the use of students.

Mr. J. W. Lovibond agreed with every word the Chairman had said in reference to the necessity of technical preparation. He took it that the object of the paper was to illustrate the weak points of the present system with a view to strengthening the education of the workers. Speaking from his own experience he considered the weak point began in the elementary schools. In no case which had come under his notice had the students been taught for livelihood, but always for scholastic purposes. The decrease in the number of students mentioned by the author was most disastrous. From his experience of technical schools he had found that the prosperity of the school depended entirely upon the satisfying nature of the teaching. Therefore looking at the matter generally the nature of the teaching in the schools mentioned was not of a satisfying character. He did not insinuate that the teachers were not competent or earnest, but they were teaching theories that were not workable in the practical life of the students. The teaching that the

Young-Helmholtz theory was the last word which could be said on the colour question had a great deal to answer for in the stagnation in that particular department. His remarks had been made with the earnest wish to advance the question and improve the status of the profession in the industries of the nations.

Mr. J. A. WILLMOTT asked whether, as the Germans were already so far advanced in the application of optics for trade purposes, it would not be better for England to leave the field of work to Germany, and pursue some other subject in which she could hold her own.

Mr. ALEXANDER HERSCHEL, F.R.S., said he had been struck with the practical value of the teaching which was called for, and instanced the improvement which had taken place in education connected with electricity and photography, owing to the practical development of those industries.

Mr. BRIDGES LEE said that while the author had given a number of reasons why it was desirable that a central institution should be found where optics should be taught, no suggestion had been made as to the precise means by which that aspiration was to be carried into effect. A very great point would be gained if it were possible to suggest some means by which such an institution could be brought into existence.

Dr. THOMPSON, in reply, said he carefully kept out of his paper any reference to the National Physical Laboratory, of which the Chairman was the head, not because he underrated the national, or even international, importance which he believed attached to that undertaking, but the National Physical Laboratory was not for teaching purposes or training students, but for research, verification, measurement, and the certification of instruments. He would be the first to dissent from any suggestion that the intention of that institution should be altered by introducing students into it for the purpose of being taught. The one place in England which was not hampered by education should not be spoiled by putting education into it. For that reason he advocated an entirely separate, independent institution which should be devoted to optics only, with a view to the technical applications of optical theories. The Chairman had poked a little fun at his earnestness in wishing for the modernisation of text-books, by reminding him that he himself was a University don who wrote a text-book on optics. He frequently consulted that text-book, and infinitely preferred the first edition, written by Dr. Glazebrook in an enthusiastic moment when he thought optics might be a little improved, but he afterwards spoiled it by modifying it to suit the examinational requirements of his own university. One speaker d suggested that because Germany had gone ahea n the application of geometrical optics the field sho d be left to them. He was not at all agreed. Engl was still spending money on educating the wr g kind of people in text-book optics. Why sh not that money be spent in teaching the r people the right kind of optics? He wis some of the technical education money to spent in training people who were in the op trade, who wished to be improved in their tr such persons, for instance, as were coming for examination under the scheme of the Spect Makers' Company. Optics were being taught to wrong people in the wrong way. Mr. Hers had pointed out a very important question. No could overlook that the subject required a cer public sense of importance. The importance c mercially of the electrical industry and the ph graphic industry had forced the question of importance of instruction on the manufacturers, how many of those people who were in the car a industry were getting any benefit of optical trai from the Government money and the Techn Education Board's money which was spent in ed tion? Precious few. In reply to Mr. Bridges L question as to whether he could suggest any prac way of carrying his scheme into effect, he tho he had got half way towards a practical sugge n when he said that an optotechnical institute t be started at Northampton-square or anywhere Why should not the London County Council Tech Education Board, which had a grant of £200,0 a year, spend in optical education some of the £20 0 a year which was not at present spent—say £2 0 in the first year, £3,000 in the second, and £4,0 in the third, as the question grew? Sir Owen Rob ts knew that he (the speaker) would like the m ey to be spent at the technical college over whic he had the honour to preside, which had done its work so strenuously in its cramped building fo he last 20 years. Although he would like to e £4,000 or £5,000 a year spent on optical lab a-tories in the Finsbury college, he recognised he fact that the Northampton Institute had taken the ad in the matter, and was training up the right cla of men. The money might be used, either at Fins ry or at the Northampton Institute, in creating a w g, if not a separate institution, in which nothing ut optics should be taught. But it must be a thoro gh technical teaching, carried out as well as poss e, without stinting expenditure upon equipment, or on competent men to teach. Why did not the me in the optical industries ask that the money which as in the possession of the Technical Education B rd of the London County Council which was not b ng spent should be spent in the instruction of optics

On the motion of the CHAIRMAN, a cordial vo o thanks was passed to Professor Thompson fo his paper.

Miscellaneous.

AUSTRALIAN COFFEE CULTIVATION.

Coffee cultivation has already been successfully introduced into Queensland, where it furnishes employment to about a couple of hundred workers. Nearly a quarter of a century ago encouraging experiments were made in the Clarence River district, in the northern portion of New South Wales, when, from the very outset, it was demonstrated that coffee trees would grow and yield good crops of berries. There were coffee trees growing in Grafton, upwards of 30 years ago, which yielded good crops, and at the present time several, over 25 years old, healthy and productive, are to be met with. The cultivation and treatment of the trees have (says a recent visitor) a great deal to do with the production of a berry of good quality and flavour. Then in the transformation of the berries into the brown powder-like substance which makes the popular beverage, there are many processes, on the proper execution of which depends the preservation of the essential qualities of the coffee in a form which readily assimilates with boiling water. The leading experiments in cultivation were made on a river island, having an area of about twenty acres, the coffee plant being grown with other crops. Last year there were about 580 trees in bearing. It is estimated that coffee should be planted 8 feet by 8 feet, which would give 680 trees to the acre. The average production of berries on each tree is 10lb., from which 2lb. of manufactured coffee is made. This, at 1s. per lb. wholesale, would be £68. The principal cost is the picking of the berries, which is put down at £3 per acre. "Pulping" costs £1 10s. for the production of an acre; fermenting, bleaching, and cleaning, £1 16s.; roasting, £3; tinning and labelling, 15s.; total, £13. 6s. for the produce of each acre. This leaves a profit of over £50 an acre, not counting cultivation expenses. These, however, are light once the trees have been planted and well grown. The ground must be kept cultivated, and the trees pruned. The work of picking the berries is light, and may be done by boys and girls, one person being able to pick from 100 lbs. to 150 lbs. per day. The next operation is that of "pulping." This is done by means of a small wooden roller, with corrugations on its surface. The object of this operation is to crack the shell, which contains two beans of a bluish white colour. The beans have also to undergo a process of cleaning. They have also to be fermented, dried, and bleached, in the course of which they must be exposed to the sun on stretchers, and brought under shelter at night, and when the weather is showery. These processes are said to cost £1 16s. for the produce of an acre. The roasting process is estimated at about £3 per acre. Last season's coffee on the Clarence and Richmond rivers is said to have established a reputation for its good quality.

General Notes.

SCHOOL OF ART WOOD-CARVING.—The School of Art Wood-Carving, South Kensington, has been re-opened after the usual Easter vacation, in rooms on the top floor of the Royal School of Art Needlework in Exhibition-road. Some of the free studentships maintained by means of funds granted to the school by the Technical Education Board of the London County Council and by the Draper's Company are vacant. The evening class has been re-opened, and will meet on three evenings a week and on Saturday afternoons. Forms of application for the free studentships, and any further particulars relating to the school, may be obtained from the manager.

THE CAPE TO CAIRO RAILWAY. — Reuter's Agency is informed that, according to advices just to hand, the Cape to Calro railway has been surveyed as far as the Zambesi, where a great steel bridge, having one span of 500 ft., will carry the line across the river at the Victoria Falls. The whole section from Bulawayo to the Zambesi—275 miles in length, or nearly 1,700 miles from Cape Town—is expected to be opened next year. Locomotives for contractors' purposes are now running on it for a short distance north of the present terminus, and a railway exploration party has been despatched over the railway route beyond Victoria Falls as far as Tanganyika. For 40 miles north of Bulawayo the earthworks are more or less complete, bridging work on the Victoria Falls section is in progress, and about five miles of line are finished. The work of connecting the Bulawayo and Salisbury sections is also progressing rapidly, and rails are already laid from Salisbury to Sebakwe, a distance of 60 miles. From the Bulawayo end of this line the railhead has reached the Arguza River, so that when this gap is filled in and the line completed trains will be able to run from Cape Town to Delagoa Bay *viâ* Bulawayo, Salisbury, and Umtali.—*Times.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

APRIL 30.—"The Timber Resources of the Australian Commonwealth." By EDWARD T. SCAMMELL. SIR JOHN F. L. ROLLESTON, M.P., will preside.

MAY 7.—"Origin and History of Carriages." By ALBERT CHANCELLOR, J.P., Master of the Coach Makers Company.

MAY 14.—"Boats and Boat Building in the Malay Peninsula." By H. WARINGTON SMYTH.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MAY 8.—"The Past and Present Connection of England with the Persian Gulf." By THOMAS JEWELL BENNETT. SIR EDWARD A. SASSOON, Bart., M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 6.—"The Printing and Illustration of the Modern Book." By CHARLES T. JACOBI. CARMICHAEL THOMAS, Member of the Council, will preside.

MAY 27.—"The Decoration of the Pianoforte." By CHARLES C. ALLOM.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments."

LECTURE III.—APRIL 28.—The photographic lens — Simple theory — Conditions of problem — Oblique refraction—Astigmatism—Coma—Chromatic aberration—Distortion—Dispersive power and refraction—Modern glass.

LECTURE IV.—MAY 5.—The telescopic objective —Conditions of problem—Photographic objective—Telephoto lens—Materials other than glass—Line of future advance—Modern glass-making—Tests of optical glass—Nomenclature.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Richard T. Glazebrook, "Glass for Optical Instruments." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. H. Hooper, "Compensations for Fruit Planting."

Actuaries, Staples-inn Hall, Holborn, E.C., 5½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. A. Rimington, "Some Principles of Painting Applied to Photography."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 29...Royal Institution, Albemarle-street, W., 3 p.m., Prof. F. York Powell, "English Kings and Kingship." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W. 8 p.m. Annual General Meeting.

Designers, Clifford's-inn, Fleet-street, E.C., 8 p.m., Mr. B. Andrew Lillie, "Design, its Demand and Supply in English History."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Exhibition of Stone Axes from Queensland. 2. Mr. H. Balfour, "Notes on the 'Goura' Musical Instrument."

Zoological, 3, Hanover-square, W., 4 p.m. Annual Meeting.

East India Association, Westminster Palace Hotel, S.W., 4 p.m. Sir Lepel Griffin, "South Africa and India."

WEDNESDAY, APRIL 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Edward T. Scammell, "The Timber Resources of the Australian Commonwealth."

Geological, Burlington-house, W., 8 p.m.

British Astronomical, Sion College, Victoria-Embankment, E.C., 5 p.m.

THURSDAY, MAY 1...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Elliot Smith, "The Mammalian Cerebellum, with special reference to the Lemurs." 2. Dr. Elliot Smith, "The Brain of the Elephant Shrew *Macroscelides proboscideus*." 3. Dr. R. Brown, "The Early Condition of the Shoulder Girdle in the Polyprotodont Marsupials, *Dasyurus*, and *Perameles*."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. S. Young, "The Preparation of Absolute Alcohol from Strong Spirit." 2. Messrs. S. Young and E. C. Fortey, "The Properties of Mixtures of the Lower Alcohols." 3. Messrs. S. Young and E. C. Fortey, "The Properties of Mixtures of the Lower Alcohols with Benzene, and with Benzene and Water." 4. Messrs. S. Young and E. C. Fortey, "Practical Distillation as a Method of Quantitative Analysis." 5. Mr. S. Young, "The Vapour Pressures and Boiling Point of Mixed Liquids." 6. Mr. S. Young, "The Correction of the Boiling Points of Liquid from Observed to Normal Pressure." 7. Messrs. S. Young and E. C. Fortey, "Vapour Pressures and Specific Volumes of Isopropyl Isobutyrate." 8. Mr. F. D. Chattaway, "Nitrogen Bromides containing the Propionyl Group."

Society for the Encouragement of Fine Arts, 9 p.m. Conversazione at the Galleries of the Royal Institute of Painters, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. S. Woodward, "Recent Geological Discoveries." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. S. G. Brown, "Automatic Relay Translation for Long Submarine Cables."

Camera Club, Charing cross-road, W.C., 8¼ p.m. Mr. E. Seyd, "The History and Use of Swords."

Civil and Mechanical Engineers, St. Ermin's Hotel, Westminster, S.W., 8 p.m. Mr. J. R. Bell, "Permissible Unit Stresses in Railway Girders."

FRIDAY, MAY 2...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. A. E. Tutton, "Experimental Researches on the Constitution of Crystal."

Geologists' Association, University College, W.C., 8½ p.m.

Junior Engineers, Westminster Palace Hotel, S.W., 8 p.m. Mr. Lewis H. Rugg, "Some Factors in Colonial Railway Construction."

Philological, University College, W.C., 8 p.m. Annual Meeting.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 3...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Walter Rayleigh, "Poets and Poetry." (Lecture I.)

NOTE.—The blocks of the figures and map illustrating Mr. Bridges Lee's paper on "Photography as Applied to Architectural Measurement and Surveying," published in the last number of the *Journal*, were kindly lent by the proprietors of the *Builders' Journal*.

Journal of the Society of Arts,

No. 2,580. Vol. L.

FRIDAY, MAY 2, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

MONDAY, MAY 5, 8 p.m. (Cantor Lecture.) RICHARD T. GLAZEBROOK, M.A., D.Sc., F.R.S., "Glass for Optical Instruments." (Lecture IV.)

TUESDAY, MAY 6, 8 p.m. (Applied Art Section.) CHARLES T. JACOBI, "The Printing of Modern Illustrated and Decorated Books."

WEDNESDAY, MAY 7, 8 p.m. (Ordinary Meeting.) ALBERT CHANCELLOR, J. P., Master of the Coachmakers' Company, "Origin and History of Carriages."

THURSDAY, MAY 8, 4.30 p.m. (Indian Section.) THOMAS JEWELL BENNETT, "The Past and Present Connection of England with the Persian Gulf."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 28th inst., DR. R. T. GLAZEBROOK, F.R.S., delivered the third lecture of his course on "Glass for Optical Instruments."

The lectures will be published in the *Journal* during the summer recess.

ORDINARY MEETING (May 14).

The meeting on Wednesday, May 14, on which Mr. H. WARINGTON SMYTH's paper on "Boats and Boat Building in the Malay Peninsula" will be read, will be at 4.30 p.m. instead of at 8 p.m.

Proceedings of the Society.

NINETEENTH ORDINARY MEETING.

Wednesday, April 30, 1902; SIR JOHN F. L. ROLLESTON, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Baldrey, Robert John, Ootacamund, Nilgiris, India.
Brooks, Joseph, F.R.A.S., F.R.G.S., Hope Bank, Nelson-street, Woollahra, *viâ* Sydney, New South Wales, Australia.
Burnham, Daniel Hudson, The Rookery, Chicago, U.S., America.
Fleming, C. A., Executive Engineer, Punjab Irrigation Department, Shahpur, Punjab, India.
Lawson, Sir Charles Allen, 15, Evelyn-gardens, S.W.
Munster, B. A., No. 23, Yokohama, Japan.
Porter, H. G. 22 and 23, Princes-street, Hanover-square, W.

The following candidates were balloted for, and duly elected members of the Society:—

Ali, Syed Akber, Firozabad, Agra, India.
Harrild, Horton, 25, Farringdon-street, E.C.
Hugo, Johannes Daniel, 64, High-street, Worcester, Cape Colony, South Africa.
Schumacher, Raymond W., Messrs. H. Eckstein and Co., P.O. Box 149, Johannesburg, Transvaal, South Africa.

The paper read was—

THE TIMBER RESOURCES OF THE AUSTRALIAN COMMONWEALTH.

By EDWARD T. SCAMMELL.

The subject upon which I have the honour to address you is one of considerable importance to the Australian Commonwealth and to the United Kingdom. It is important to Australia, in view of the fact that her timbers are a valuable, and should prove a permanent asset, and to the United Kingdom—(1) because of her desire to promote the commercial prosperity of her Dependencies, and (2) because her timber markets are always open to suitable timbers which can be offered on terms which may render business possible and profitable.

In dealing with the timber resources of Australia, it is not my intention to give you a detailed account of them, for such an undertaking, however interesting to the botanist, would be, for practical purposes, useless. The object I have in view is to serve, as far as possible, the commercial interests of the Australian Commonwealth, by demonstrating the claims of Australian timber to the favourable consideration of municipal, railway, and marine engineers, architects, builders, and cabinet and art workers, and to give only such particulars as may be serviceable to that end.

I am glad to have the opportunity of performing this duty, both as a member of this Society, and as one who, for a number of years, has interested himself in Australian affairs, and who now has the honour to represent one of the States whose timber resources will be passed under review. So far as this Society is concerned, as it seeks the commercial as well as the artistic and scientific interests of its members and of the public at large, it is quite in accordance with its principles and scope that a subject of this nature should be treated here.

It will be remembered that last year a very important paper was read in this hall by Professor Schlich on "The World's Timber Supply," which was followed by a discussion of high value. That paper had, evidently, some weight with the British Government, for, during the last few weeks, a committee has been formed, under the auspices of the Board of Agriculture, "to enquire into and to report as to the present position and future prospects of forestry in Great Britain." I trust that that committee will also give at least passing attention to the question of forestry in our Colonies in order to assist the movement there—a movement, the value of which to the Empire at large it would be difficult to over-estimate.

In 1897, a "Commission on State Forests and Timber Reserves" was appointed by the Parliament of Victoria. That Commission concluded its labours in March, 1901, after taking a mass of evidence and making a most careful examination of the whole subject. In the 14th and final report, issued a few months ago, a copy of which I have had the opportunity, through the courtesy of the Victorian Agency, of studying, an interesting account is given of the forest resources of Australia from which I purpose borrowing my introduction. The report says;—

> The true forest region of Australia is almost entirely coastal; that is to say, the most luxurious tree growth is confined to the mountain and hill ranges, which to a large extent follow at a moderate distance the trend of the coast, and to the tablelands and foothills which stretch from these toward the shore line. Where, however, the ranges approach closely to the ocean, as is the case with the Darling hills in Western Australia, the forest belt may extend beyond the watershed some distance inland, its limits being clearly marked by a greater rainfall and a more temperate climate. Thus in Western Australia, the great belt of jarrah, some 350 miles in length by 50 to 100 in breadth, which stretches eastward from the Darling Ranges, has two distinct but narrow belts of tuart and red gum between it and the coast. Within the extensive tract of jarrah, in the extreme south-west of the colony, is the main karri belt, stretching from Cape Hamelin to Torbay, and lying between 115° and 118° East Longitude, and 34° and 35° South Latitude. This region in which the jarrah, karri, tuart, and red gum are the dominant trees, has an annual rainfall varying from 35 to 40 inches. In somewhat drier districts stretching eastward of the jarrah belt, there is a fairly wide strip of white gum, enclosing a narrower belt of York gum, which, as regards its northern and southern limits, is almost coterminous with the jarrah. Eastward of this again the arid region, where the annual rainfall is some 14 inches and under, is entered, and the forest rapidly dwindles, changing first to a poorer growth of white gum, until, in the sandy wastes of the goldfields region, the vegetation changes to brush, scrub, and dwarf trees, the latter being chiefly the eucalypts, locally known as salmon, morrel, and gimlet gums, with some belts of pine at intervals. Along the shores of the great Australian Bight the vegetation is scanty and inferior, consisting chiefly of stunted eucalypts of the kinds of the last-mentioned, casuarinas, the cyclopis wattle, and grass tree. It is not till the province of South Australia is entered that any elevated country is met with, and there the Flinders, Gawler, and Mount Lofty Ranges are merely chains of hills of inconsiderable extent. In these ranges the timber consists of the sugar gum, the white ironbark, two varieties of stringy bark, the white or manna gum she-oak, and in the valleys and ravines red gum. It is, however, when the western part of Victoria is reached that the commencement of the great mountain system, as well as forest region, of Eastern Australia is seen.
>
> The forest region of Southern Victoria corresponds to a considerable extent with that of Tasmania, the principal eucalypts being blue gum, spotted gum, messmate, stringy bark, silver-top ironbark and mountain ash, with evergreen beech and acacias, such as the blackwood and several species of wattle. In the northern part of the colony the trees are of a kind common to New South Wales. Thus the level country bordering the River Murray and its southern tributaries is the home of the flooded variety of red gum, intermixed with greybox and (near the Murray) cypress pine, while the undulating land and low Silurian ridges between that river and the mountains are covered with two species of ironbark, stringy bark, and several kinds of box. In New South Wales and Queensland, between the Dividing Range and the

Pacific, are found some of the finest belts of forest on the Continent. Among eucalypts are several varieties of ironbark, tallow-wood, black-butt, grey gum, spotted gum, turpentine, forest red gum, and red mahogany; among conifers the Moreton Bay, brown, and Bunya Bunya pines; while among the brush timbers of fine grain are red cedar, rosewood, redbean, blackbean, beech, silky oak, beef-wood, and tulip. Westward of the ranges in New South Wales, where the table land sinks down to undulating country and vast plains, through which the tributaries of the Murray make their way, the vegetation changes to scrub and open forests, consisting of eucalypts, such as red gum along the water-courses, with several varieties of box, cypress, and other pines and wattles. Further inland again the timber becomes more sparse, being chiefly cypress pine, stunted eucalypts, and casuarinas, with extensive areas of mallee scrub. In Queensland a large portion of the country west of the Divide is an extensive plateau running into great plains, well-watered and covered with rich grasses, but with little timber. Towards the centre of the continent where the land gradually falls to a vast shallow basin with low hil ridges at intervals on its rim and wide expanses of plain country with short watercourses losing themselves in the desert, the tree growth is very scanty, consisting of stunted eucalypts, such as the gimlet-gum (E. salubris) and E. microtheca, the desert she-oak, acacias, and mallee.

FOREST AREAS.

The following Table, showing the extent of country estimated to be under forest in the six States of the Australian Commonwealth, is based on special returns given to the Victorian Royal Commission by the several Governments :—

State.	Area in Sq. Miles.	Area in Acres.	Forest Area in Acres.
Queensland	668,497	427,838,080	40,000,000*
New South Wales	310,372	198,638,080	20,000,000
Victoria	87,884	56,245,760	11,797,000†
South Australia	903,690	578,361,600	3,840,000
West Australia	975,920	624,588,800	97,920,000‡
Tasmania	26,215	16,778,000	11,000.000
	2,972,578	1,902,450,320	184,557,000

* Marketable timber. Probably one-third of the State may be said to be well covered with timber, of which a large quantity has a local value for building and other purposes.

† Reserves and proposed reserves of all kinds, 5,525,000 acres; inaccessible country, 6,272,000 acres.

‡ About 20,400,000 acres are covered with marketable timber, while the remainder bears trees useful for local purposes (inferior timber and brushwood).

1st. From this description, you may judge the wide area my paper must cover, and will sympathise with my intention to restrict it to those timbers, and those only, which may be regarded as *commercial timbers*, by which I mean those that are, at present, extensively used for engineering, constructive and ornamental purposes in the various States, and that are or may be made available for exportation.

In determining the leading timbers of this class, I have collated a large amount of information, readily supplied me by the Agencies in London, and obtained from other sources; but to place all the details and particulars that are at hand in order of importance, and to give each State all the consideration it requires, I have found to be a work of considerable difficulty. Instead, therefore, of attempting to make a new path through the forest, I have deemed it wise to follow the lead of the Victorian Commission, and to place the various woods in the order in which they mainly stand in their report.

This word of criticism, by way of introduction, I feel bound to offer. No adequate account has been given in that report, nor can any satisfactory information be obtained from the various State Agencies, with the exception of Western Australia and Tasmania, as to what timbers are really available for export, or what prospects there are for an enlarged export trade. This is a matter, however, to which, in a word or two, I propose referring at the conclusion of my paper. But I wish this fact to be borne in mind, as I indicate the chief timbers of the various States.

In my description I shall deal somewhat fully with the woods of New South Wales, because they may be regarded as generally representing those of Queensland, Victoria, and South Australia, of which, therefore, I shall be required to say comparative little.

NEW SOUTH WALES.

The principal hard wood of this State is *Ironbark*, of which there are four varieties, *the white or grey* (Eucalyptus Paniculata), *the narrow leaved* (E. Crebra), *the broad leaved* (E. Siderophloia, the Ironbark of Queensland), and *the red* (E. Sideroxylon). Of these, the first two are the most important. The white ironbark produces a timber pale in colour, while that of the narrow leaved is deep red. Both are very hard, and are used for bridges, culverts, railway sleepers, fencing posts, and wheelwright work. The beams of this timber are of great strength.

Tallow-wood (E. microcorys, also known as the turpentine and peppermint of Queensland) comes next in importance; but the supply appears to be limited. The wood is of a clear yellow or light reddish colour when newly cut, but changes afterwards to a pale brown. Its common name is due to the greasy nature of the wood. It is not only useful for bridge decking, house flooring, girders, piles, and fencing posts, but it makes an excellent paving wood. It is, at present, very much in use in the streets of Sydney for this purpose.

Blackbutt (E. pilularis) is specially adapted to house and shipbuilding, and bridge decking. It is also useful for paving purposes.

Grey Gum (E. propinqua), while similar in appearance to Blackbutt, and by some regarded as an efficient substitute for it, is not suitable for long girders or beams. Its special use is for coachbuilder's work—felloes and spokes.

Murray Red Gum, also called Flooded, Red, or White Gum (E. rostrata) is *the common River Gum* of all the Eastern States. It is not so easily split as Blackbutt, as it is unusually short in the grain and interlocked. It is one of the best hard woods for contact with the ground. For street paving, it has the common fault of Australian woods, especially those that are not properly seasoned, or sufficiently matured, viz., contraction and expansion when newly laid; but it is very durable, and one oi the most abundant of Australian Eucalypts.

Another and important variety of *Red Gum* (E. tereticornis, the Grey, Blue, or Flooded Gum of Victoria, and the Blue Gum of Queensland) is of a similar character to the E. rostrata and is a widely distributed tree.

White Mahogany (E. acmenoides, the Stringy Bark of Queensland) is somewhat like Tallowwood, and is often substituted for it. By some it is regarded as more durable than Ironbark or box. It is a pale-coloured timber, tough and hard.

Another well-known and valuable tree is the *Red or Forest Mahogany* (E. resinifera). The wood is of a rich red colour, very durable, and, like many other Eucalypts, hardens with age It resists the attacks of the termite (white ant), and is useful for general building purposes and street paving.

Grey Box (E. hemiphloia, the Gum-topped Box of Queensland) is useful for sleepers, piles, girders, and wheelwright work.

Brush Box (Tristania conferta, the Brisbane Box of Queensland) is of a grey or brownish colour. It is especially used for tram rails, tool-handles, and works requiring a tough, hard, and elastic material.

Sydney Blue Gum (E. saligna, the Grey Gum of Queensland) is easily worked, suitable for buildings, and is greatly valued by shipwrights and wheelwrights. In the northern part of New South Wales it is used for paving blocks.

Woollybutt (E. longifolia), like red mahogany, belongs to the Jarrah class of hardwoods, and is another useful wood for street paving. Its timber is dark red, not unlike Red Ironbark. It is too brittle for girders and sleepers.

Spotted Gum (E. maculata) is a tough timber of a pale, yellowish brown. It is one of the best hard-woods for bending. It is largely used for poles, shafts, cross pieces, naves, and spokes. It also makes a good paving wood. The gum of this wood is said to contain 34·97 of kino-tannin.

Turpentine (Syncarpia laurifolia) is useful for piles and dock purposes generally. It resists the white ant and, in tidal waters, the teredo or cobra. Its immunity, in the latter case, appears to arise from the oleoresin which is secreted between the timber and bark, as in other woods of the same character. Hence, piles should always be driven with the bark intact. This wood, however, is disliked by the sawmiller, as it quickly dulls his saw. The same may be said of other Australian hard woods, but this is a mechanical difficulty which ought not to stand in the way of the adoption of otherwise useful timbers.

There are several varieties of Conifers in New South Wales.

Moreton Bay (so-called from its Queensland habitat) or *Hoop Pine* (Araucaria Cunninghamii) is the principal cheap soft wood, and is used for packing cases, flooring, ceiling, lining boards, and butter boxes. It is far inferior, however, to the leading Pines of Europe and America.

Brown Pine, otherwise Colonial Deal, White Pine, and Pencil Cedar, known also as the Native Plum or Damson (Podocarpus elata, the She Pine of Queensland), is a much harder and more durable wood than the Moreton Bay Pine, and is used for bridges and pier piles. It resists the white ant and, in salt or brackish water, can withstand, if the bark be left on, the attacks of the teredo.

The Cypress Pine (Callitris) has several varieties—the red or black pine (C. calcarata), the Murray pine (C. verrucosa or Fenela robusta), the Port Macquarie Pine (C. Macleayana), and the Richmond River Cypress pine (C. Columellaris). This series of Pines is used largely for building purposes, and for bridge decking. They are seldom attacked by white ants. Resin obtained from the Callitris verrucosa, and from one or two other Australian Pines, is available in considerable abundance. It is almost identical with the best sandarac of Northern Africa, largely used in the manufacture of varnishes.

A very excellent timber is the *Red Cedar* (Cedrela Australis, or the Cedrela Toona of Queensland), which is very similar to American Mahogany, but only half its weight. It is easily worked and is very durable. It is chiefly used for furniture and cabinet work. Scantling or small pieces, with figured grain, furnish timber of great beauty.

Red Bean or Turnip Wood (Dysoxylon Muelleris, the Pencil Cedar of Queensland), is a good furniture wood. It has a finely figured grain, and is often sold as cedar.

Rosewood (Dy. Fraserianum, also a Pencil Cedar of Queensland), so called from the odour of the wood when fresh cut, is like Red Bean, of a reddish colour, and is suited for cabinet making and joinery. It is also said to furnish an excellent material for wine casks.

White Beech (Gmelina Leichardtii, the Queensland Beech) is a strong, close-grained timber, easy to work, and durable. It is in great request for decks of vessels, furniture, picture frames, carving, and general house fittings. It is also much used in coopers' work.

Silky Oak (Grevillea robusta or Orites excelsa) is much in demand for cabinet and coopers' work, and butter boxes. There is a large available supply of Orites excelsa. The timber splits easily, is of a light colour, and shows a fine oak-like grain.

Black Bean (Castanospermum Australe, the Moreton Bay Chestnut of Queensland) is a dark coloured wood, close grained, and durable, similar in appearance to walnut. It is a good furniture and cabinet wood, and makes excellent gun stocks.

Tulip Wood (Harpullia pendula) yields a hard, close-grained timber, marked with irregular streaks. It is highly esteemed for cabinet making, for door panels, dadoes, and billiard tables. It resembles olive wood in appearance.

Coach-wood (Ceratopetalum apetalum) is a light, soft, close-grained and tough timber, suitable for boat building, cabinet work, and, as its name denotes, coach-building.

As I have before stated, in describing thus fully the principal commercial timbers of New South Wales, I have anticipated much that might be said respecting the woods of other Australian States. The general description and uses now given will suffice, therefore, with some exceptions, for them all. There are differences, of course, in the quality of the timber, even of the same tree, in different States, and indeed, in different parts of the same State, differences arising from soil, climate, and general surroundings. But, in each case, as far as I know, a fair average description has been given.

VICTORIA.

According to the report of the Victorian Royal Commission, among the principal trees of this State are the *River Red Gum* (E. rostrata, the Murray Red Gum of New South Wales), the *Red Ironbark* (E. leucoxylon, a variety of ironbark), the *Grey Box* (E. hemiphloia) and the *Cypress Pine* (callitris verrucosa, the Murray Pine of New South Wales), all of which have been described in the list of New South Wales' woods.

In addition to these, are the following:—*Bairnsdale Grey Box* (E. Bosistoana), which furnishes fine and durable pile timbers up to 60 or 70 ft. in length, and which has also a high repute for railway, bridge, and wheelwrights' work.

Stringy Bark, of which there are three varieties (E. Macrorrhynca, E. capitellata, E. piperita), all of which are used for building and general purposes. There is also the *Yellow Stringy Bark* (E. Muelleriana) which is a strong and tough timber suitable for harbour works.

Blue Gum (E. globulus) and *Messmate* (E. obliqua) the same as the Tasmanian Stringy Bark), will be dealt with under Tasmania, where they are leading timbers.

Spotted Gum (E. goniocalyx) is different from the wood of the same name in New South Wales. It is similar to Blue Gum (E. Globulus), for which, whether by error or design, it is often sold—a practice that is open to much objection whatever the quality of the wood may be.

Yellow Box (E. melliodora) is a heavy and inlocked wood suitable for piles and posts.

Blackbutt, otherwise the common Mountain Ash or Peppermint (E. amygdalina regnans), is the tallest tree of the Victorian forests, if not of the whole continent. It is a different wood from the Blackbutt of East Gippsland, Victoria, which is the same as the New South Wales variety, and it differs also from Western Australian Blackbutt (E. patens). The Victorian wood is like English Oak in appearance when properly seasoned, and is used for building purposes. The inner bark is adapted for the preparation of all kinds of coarse paper, and the foliage contains a greater amount of oil than any other of the Eucalypts. One thousand pounds of fresh-gathered leaves, with their small branchlets, will yield about 500 oz. of oil by distillation.

Silver-top or *Bastard Ironbark* (E. Siberiana and E. virgata), called also Mountain Ash, Green-top, and White Ironbark, known in New South Wales as Mountain Ash, and in Tasmania as Ironbark, is used in both varieties for building purposes.

Of fine grain woods, the chief is *Blackwood* (Acacia melanoxylon), an exceedingly valuable tree. It has, however, been so extensively sacrificed, like many valuable Australian trees, in the course of land settlement, that it requires careful conservation to preserve the remains of the splendid forests in which it grew abundantly years ago. I propose to describe this tree, in dealing with Tasmania, as also the *Evergreen Beech* (Fagus Cunninghamii) which yields a fine timber. There are two Victorian varieties of this wood, one a greyish white and one a reddish colour.

The above list of commercial timbers in Victoria differs, in some respects, from that contained in a report by Mr. A W. Howitt, Secretary for Mines, on "the present and future supply of Victorian Eucalypts, and on the possible establishment of an export trade in timber." But as that report was written in 1895, I have judged it best to select the more recent report of the Royal Commission on which to base the particulars and order of value here given.

TASMANIA.

Tasmania which, from the similar character of its flora, is naturally associated with Victoria, possesses, with the exception of Western Australia, the largest supply of timbers available for export of all the Australian States. Recently its Government has issued certain "Particulars relative to locality, extent, characteristics, uses, and facilities for transit, of the Commercial Timbers of Tasmania," from which I propose to make some extracts :—

Blackwood or Lightwood (Acacia melanoxylon) is found all over the island, and, in many parts, is very plentiful. It is extensively used for furniture, panelling for railway carriages, wainscotting, and interior fittings. It resembles Cedar in appearance. It has been used by Messrs. Alcock and Son, Melbourne, for billiard tables, Messrs. Collard and Collard, London, for pianos, and it has lately been supplied to the Admiralty for gun-carriages, having satisfactorily passed the necessary tests in the Government arsenals.

Myrtle (Fagus Cunninghamii, the Evergreen Beech of Victoria) is abundant. It has been favourably reported upon by Messrs. Ransom, saw-mill and [mechanical engineers, Chelsea, for its strength and high finish. Its value for ball-room and other floors, where there is great traffic, is shown in the fact that it wears quite smooth, does not shred or tear, and is singularly free from knots or faults.

Huon Pine (Dacrydium Franklinii) is a very durable timber, and is practically indestructible in water. It is used extensively for railway rolling stock, cabinet, and high-class furnishing work, and boat planking.

She Oak (Casuarina quodrivalvis) is a small tree, but it provides a handsome ornamental wood, suited for cabinet and interior work.

Blue Gum (E. globulus) is the most important of Tasmanian timbers, and is in considerable demand for harbour works and other purposes. Good piles, like those being supplied for the national harbour works at Dover, can be obtained up to 100 ft. in length, with only a moderate taper. The grain being interlocked, it makes a good wood for felloes, while the young wood, from its toughness and elasticity, is much used for shafts and spokes. Blue Gum has been tried for wood paving in London, but from want of care in the preparation of the wood, or from other causes, it has not proved a success.

Peppermint (E. amygdalina) is similar to, if not identical with, the Blackbutt of Victoria (E. amygdalina regnans). It is plentiful in Tasmania, and is specially used for roof timbers, but it is less pliant than most other Eucalypts.

Swamp Gum, Stringy Gum, or Gum-topped Stringy (E. regnans) is the most common of all Eucalypts in this State. It is in large demand in the local market for building and general purposes.

Stringy Bark (E. obliqua), is also very widely distributed. It is identical with the messmate of Victoria, and is regarded by some as the most valuable hard wood of the Australian forests. The grain of this wood renders it, when properly seasoned, especially suited for wax floors, as it has a very brilliant appearance, is handsomer than oak, and takes a good polish. It is used extensively for piles and other dock purposes. It should be serviceable for street paving, as it is tough as well as hard, but for its great tendency to warp and shrink, which can, evidently, only be overcome by careful seasoning and preparation.

Ironbark (E. siberiana), the silver-top or Bastard Ironbark of Victoria,'possesses similar qualities to blue gum. The wood has a reddish tint.

QUEENSLAND.

Most of the timbers described under New South Wales belong to this State also : but there are many others of commercial value found in the extensive forest areas of the country. At present, however, they are inaccessible, or no systematic effort is being made to exploit them. In time the timber resources of this State will doubtless receive more attention. As the estimated extent of forest (in which trees, having a local use, are found) is equal to a third of the whole area of the country, while valuable commercial trees, which might be made available for export, cover some 40,000,000 acres, Queensland should, ere long, do a large and flourishing timber trade.

In addition, however, to the varieties referred to under New South Wales, this State possesses some other timbers which should not pass unnoticed. Among these are the following :—

Woollybutt (E. botryoides) is a red coloured, close grained, tough wood, useful for constructive and wagon work, and when large beams of hard wood are required.

Bloodwood (E. corymbosa) is a durable wood if used whole for piles, posts, &c. It is also red in colour.

Kauri Pine (Agathis Palmerstonii or Agathis robusta) is similar to the famous Kauri P. (A. Australis) of New Zealand. The wood is of a light yellow colour, free from knots, soft, and easy to work. It is largely used for house building.

Red Bean, identical with the New South Wales Black Bean (Castanospermum Australe), is regarded as a very valuable timber for general purposes.

Swamp Mahogany (Tristania suaveolens), whose wood resembles Spanish Mahogany, is a hard and close-grained timber, fitted for underground work and piles. It resists the ravages of the teredo better than any other Queensland wood.

Paper-barked Tea Tree (Melaleuca leucadendron), a number of varieties of which are common throughout Australia, is also valuable for underground work and piles.

Gidgee or *Gidia* (Acacia homalophylla) is a small tree whose wood is prettily marked and makes excellent pipes—a good substitute for briar.

SOUTH AUSTRALIA.

This State has the smallest area of forest land of all the Australian States, and is therefore quite unable to enter the lists as an exporting country. The Government, however, is pursuing a very prudent course in planting large quantities of the most useful commercial trees, suited to the soil and climate, and is doing its best to encourage the growth of trees indigenous to the State, such as the *Sugar Gum* (E. Gorynocalyx), a useful wood for railway and general purposes, which is said to be as durable as Jarrah, aud equally able to resist the attacks of the teredo. Two other Eucalypts, the *White Ironbark*, locally known also as Blue Gum (E. leucoxylon, the Red Ironbark of Victoria), and the *Grey Box* (E. hemiphloia), common to Victoria, furnish strong, tough, and durable woods, inlocked in grain and suitable for the same purposes as Sugar Gum. The common flooded variety of *Red Gum* has a fairly wide distribution in this State. Among *Conifers* which have been grown with fair success are the Monterey, Maritime, Aleppo, and Stone Pines. But, in view of local needs, it will be many years before the forests of South Australia are likely to prove a source of revenue from any export trade.

WESTERN AUSTRALIA.

The development of the timber industry of Western Australia in recent years, places this State in a unique position in relation to the timber trade of the whole Commonwealth. To quote a late issue of the Government Agency : "One special advantage of the Western Australian timber industry, lies in the fact that it is more completely and efficiently organised than that of any other Australian State, so that it can provide a continuous supply of timber on terms which may bring it within the reach of the home and Continental trade." This applies mainly to the two woods which form the bulk of the timber exports of the State, viz., Jarrah and Karri. But, it may also relate to other timbers which are available for export, of which I propose to give a brief review.

The first export trade of any kind done by Western Australia, was in *Sandal Wood* (Santalum cygnorum), shipments of which have been made since 1849. The present quality of this excellent wood is said, in a recent report of the Woods and Forests Department, to be inferior, owing to the want of care on the part of the cutters, in properly preparing it for the market. This matter, however, is receiving attention as is the general question of the conservation of this useful and revenue producing timber.

But by far the leading and most popular wood of the Western Australian forests is *Jarrah* (E. marginata). The late Mr. J. Ednie Brown, formerly Conservator of Forests, in the last report he wrote to his department, says:—

> "*Jarrah.*—It is predominant above all others in its extent of forest, the various uses to which it is or can be applied, the part which it is now taking in the great timber export of the colony, and the esteem in which it is held in this country. There are other timbers in our forests which are equally if not more valuable for their own special purposes, but for general constructive works necessitating contact with soil and water, the timbers of these trees stand foremost in these forests."

Mr. Brown says that there are considerable areas of Jarrah forest, where the matured trees attain a height of from 90 to 120 ft., with good stems 3 ft. to 5 ft. in diameter, and 50 ft. to 60 ft. to the first branch. He considers that in good situations Jarrah will attain maturity in about 40 to 50 years. He refers to its immunity from the white ant and the teredo, and speaks of the apparently indestructible character of the wood, when thoroughly seasoned. He lays particular stress upon this last point, and upon the necessity of felling at the right season of the year. The general purposes for which Jarrah is used are so well known as to need no detailed description.

Karri (E. diversicolor), which comes next in importance, was at first called E. collosea, from its magnificent growth. Baron Von Mueller, however, gave it the name of diversicolor from the appearance of its leaves. Mr. Brown calls it the giant tree of Western Australia, if not of Australiasia. He says that "an average tree may be put down at 200 ft. in height and 4 ft. in diameter, at 3 ft. or 4 ft. from the ground, and about 120 ft. to 150 ft. to the first branch." "The timber is red in colour, and has very much the appearance of Jarrah, so that it takes a good judge to distinguish them. "For lateral strength," Mr. Brown says, "it is very much stronger than Jarrah, and for constructive works—bridges, floors, rafters and beams—it is of great value." He regards it as more suitable for wood paving blocks than Jarrah, although he considers that, in the main, Jarrah is the more reliable and better wood.

Both these trees occupy large and compact forest areas which greatly facilitate the operations of timber getters. Jarrah covers some 8,000,000 acres, and Karri about 1,200,000 acres, within a comparatively short distance of the coast and in parts within easy access of railway communication.

One characteristic of these timbers, which they share with other Eucalypts, particularly the West Australian Blackbutt, is their comparative non-inflammability. I had the opportunity of witnessing a fire test in January last carried out by the British Fire Prevention Committee, London, the results of which were most satisfactory. This question is one of great importance to all who are concerned in engineering and structural works, in which immunity from fire is a matter of moment. The recent terrible accident at Liverpool on account of the firing of creosoted sleepers may be regarded as a case in point.

But to pass to other timbers of this State.

Tuart (E. gomphocephala) is one of the most valuable of all Australian woods, being the strongest and the toughest of them all. Unfortunately, the forest area of this excellent tree is so limited, that only a small export trade could be done with it.

Red Gum (E. calophylla) has, however, a very wide range, and is a strong and useful wood. Its usefulness is occasionally impaired by the numerous gum veins which intersect it in every direction, and from which the gum exudes in considerable quantities. But this product has its commercial value, as it possesses important medicinal properties, and is used locally for tanning purposes. The term "Red Gum" is one common to many Australian Eucalypts, particularly to the E. rostrata of Victoria and the E. resinifera of New South Wales.

Wandoo (E. redunca) is a wood that needs to be better known. It covers a considerable area, and it is computed that there are from six to seven million loads of marketable timber available for use or export. It is well suited for railway and wheelwright work.

Blackbutt (E. patens) is also worthy of attention, as it is not only useful for wheelwright and wagon work, but, according to

Mr. Brown, would make an excellent paving wood.

York Gum (E. loxophleba), another widely distributed timber, is a strong, tough wood, suited for general purposes.

The same also may be said of the *Yate Gum* (E. cornuta) and other Eucalypts of this nature, of which this State and Australia generally, possess a great variety.

A passing word should be said on behalf of the *Wattle*, the general term throughout Australia for the large family of Acacias. Here, the A. saligna, or, according to Mueller, the A. leiophylla, is one of the leading Acacias. It supplies a valuable tannic acid—mimosa tannin—of which the bark contains about 30 per cent. The well-known *Raspberry Jam* (A. acuminata) is a beautiful wood suitable for cabinet work. Another acacia, the *Badjong*, or wattle gum (A. microbotrya) is suited for barrel staves, and for soft wood turnery.

Then there are the *She-oaks* (Casuarinas), of which the C. Fraseriana produces a good furniture wood, light in weight, and beautifully grained; the *Banksias*, of which there are many varieties, some of which are specially suited for decorative work; the *Native Pines* (conifers), the leading member of which is the well-known Cypress Pine (callitris verrucosa), which is useful for house and boat building, furniture, and fancy work; and the Paper Bark Tea Tree (melaleuca leucadendron), the wood of which is suitable for ship building and the bark for fruit packing.

A forest ranger of Western Australia, in a recent report to his department, referring to the uses of some of the timbers I have named, especially for wheelwrighting, says: "I have seen wagons built of these woods that have been in rough and constant use for many years, during which time they have been innocent of paint or shade, and yet to-day their timbers are in a splendid state of preservation and soundness." He, however, urges the necessity of thorough seasoning, and says, "In the natural seasoning of timber care should always be taken to season in a dark shady place, as sun shakes affect the timber prejudicially." He is of opinion that a profitable commercial future is in store for many by products of the forest. "From timber trees, formerly looked upon as valueless, endesmol, geraniol, dyes, essential oils, camphor, and other valuable commercial products have been obtained." This of course applies generally to all the forests of Australia, which in their sunny depths may be storing many sources of wealth besides timber.

Before concluding my reference to Western Australia I think it necessary to say a word or two about the special trade which that State has succeeded in creating in the matter of paving woods. It is now thirteen years ago that the first serious trial of Jarrah wood blocks was made in the streets of London, when a section was laid in Westminster Bridge-road. Since then, many miles of Jarrah and Karri have been laid in the metropolis, in provincial towns of the United Kingdom, and on the Continent of Europe. Other Australian woods also have been tried. Among these are Blue Gum and Stringy Bark from Tasmania, Crows Ash (Flindersia Australis) and Tallow-wood from New South Wales, Blackbutt and Bloodwood (E. corymbosa) from Queensland, Ironwood (Tarrieta argyrodendron or T. actinophylla) from New South Wales or Queensland. No settled or systematic effort appears to have been made, however, to popularise these woods. Indeed, from the fact that some of them were exported in an evidently unprepared state, it would seem that the conditions of the trade were not carefully considered by the first exporters—to their disadvantage and to the discouragement of further efforts. But Jarrah and Karri have been sedulously pressed upon the attention of municipal engineers, by the energetic representatives of the timber companies operating in the State, and by the Government, with the results we know. Into the question of how far these woods have proved successful for the purpose required, it is not my province now to enter. I can only say that, provided these and other Australian hard woods are properly prepared and efficiently laid, they constitute an excellent paving material.

I have just had the opportunity of reading an important report on the hygienic character of "Various wood pavings used in the London streets," by Drs. John Norton and F. Wilson Hake, of Westminster. Certain blocks of Jarrah, Karri, American Red Gum, and Plain and Creosoted Deal were subjected to a careful chemical and bacterial examination. In the concluding paragraphs of the report the examiners say:—

> "Taking a final classification of the hygienic character of the woods, both as regards the number of organisms and the importance of the organisms, Karri was found to be best, Jarrah the next best . . . .
>
> "Both the chemical and bacterial examinations of the five woods have, therefore, without a doubt

demonstrated that Karri and Jarrah stand in the first and second ranks respectively of the most hygienic wood used for wood pavings, and these two woods are much less absorptive than any other woods yet used in the streets of London. Moreover they possess, especially Jarrah, those natural anti-septic properties which are so essential for woods exposed to decomposing substances."

In the second part of my paper, I propose to deal as briefly as possible with the question—*What are the prospects of the timber trade of the Australian Commonwealth with the United Kingdom?*

The value of the total British imports of hewn and sawn timber for 1900, according to the Board of Trade Returns, amounted to £29,350,638. Of this enormous sum the amount contributed by all the States of the Commonwealth was £302,109. The amount, however, as given under the head of Exports, "Timber—domestic produce and manufactured," in the States' Returns for 1900 is £194,816, divided as follows:—Western Australia, £187,464; New South Wales, £6,637; Queensland, £675; Victoria, £40; South Australia and Tasmania, *nil*. Even taking the higher figure, the contribution of the Australian Commonwealth towards the total British imports of 1900, was ridiculously small. The question therefore arises, seeing the great market which this country affords and the considerable timber resources of Australia, is it not possible to alter this state of things for the better?

I am fully aware that there is one difficulty of immense importance—*the distance of Australia from the Mother country* and the consequent cost of transit. But, surely, in these days of shipping combination, with increased economic management, one would venture to think that some arrangement might be made to cheapen freights, so as to make it possible for Australia to compete with other countries for the supply of high class, if not common timbers. This is a matter, however, for the consideration of shipping companies, and, it may be, the various State Governments, as well as the millowners of Australia, and the timber companies operating with Australian timbers.

But there are some other questions relating to *methods of production and of business in Australia*, to which I think attention should be called.

Sir William Thistelton Dyer, in the discussion on Professor Schlich's paper on "The World's Timber Supply," is reported to have said "he was not very hopeful that Australasia would ever do much to aid the timber supply." May we ask, why not? The timber is there, and of its suitability for many classes of work there can be no question. Is it because the exporters or the producers do not quite understand the requirements of the home market, and so do not take sufficient care in preparing their woods for it, or in arranging for a continuous supply at such prices and on such terms as would render trade possible?

I fear that there may be something in this question, as there appears to prevail an opinion among some of the producers in Australia that the English market will or should take just what they like to send it. The timber may be immature, unseasoned, and defective in other respects. It may have been cut from trees grown in varying soils and under dissimilar conditions. And the whole may be sent in one consignment without being marked or graded in any way. In this case, the importer, unless he be skilled in this species of timber and be able to examine his consignment in detail would be quite unable to determine its real value, and would have to wait until the user had determined it for him. It would not, therefore, be surprising, if disappointment and failure ensued, and the prospective trade be ruined. Now, if this be so to any extent, there is clearly need of improvement, if any effective business, on a large scale, is to be done.

Care, also, appears to be required in what the Victorian Commission calls "*working practice," in the forests themselves.* In an instructive paper, by the late Mr. G. S. Perrin, F.L.S., read before the Royal Victorian Institute of Architects, Melbourne, in 1893, at the time he held the position of Conservator of Forests of Victoria, he said, "I would point out to all interested and strongly urge the importance of placing their timbers in the best possible condition in the hands of their customers on the other side of the water." In order to this, he suggests among other things: (1) the ring-barking of all trees, intended for sawing, at least three months prior to placing on the bench; (2) the cessation of the system of cutting timber at the mills in a perfectly green state; (3) the stoppage of the system of selection of young and immature trees, such trees being invariably filled with sap and half-formed wood, yielding quickly to decay; and (4) that care should be taken that none but the best trees are selected and that the sap wood and heart wood be carefully excluded. In treating of ring-barking, he says, this is important "as the tree in its perpendicular position is more rapidly drained of its sap and natural juices when once the bark is cut through into the wood." He condemns the practice of "allowing the log to remain on the ground, in a horizontal position, when the sap and the acids contained in the trunk percolate into the tissues and must remain there decomposing and gradually rotting the log." "This question," he continues, "cannot be too strongly impressed upon mill-owners." He admits that it is not easy to fix the time for ring-barking on any hard and fast lines, because of differing local conditions. But it should be done when the sap is down.

What effect the publication of these views may have had in Australia, I am not in a position to say, but I have recently read a statement made by a forester of Western Australia, who claims a life-long experience in timber work, whose opinions certainly are not in harmony with those of Mr. Perrin. He speaks of the sap and the gum in Jarrah and other Eucalypts as being "the life blood" of the tree, and contends that the tree should be cut when the sap is up, because then it retains all its preserving qualities! When the sap is down, the tree is in a semi-dead state, and its lasting qualities are lessened! He therefore condemns ring-barking. Apparently the engineer, who thinks that sap should be expelled, has made a mistake. For if, according to this opinion, you get rid of the sap, you lower the quality of the wood.

Another writer on the subject of Western Australian woods, speaking with authority respecting the gum (kino) in Jarrah, and rightly arguing as to the value of this substance, complains that the foreign buyer of this timber often rejects it because it shows "gum veins," whereas these veins show the excellence of the timber in which they are found. While this may be perfectly true as to the quality of the other parts of the wood, it is not an easy thing to convince an engineer that gum veins are satisfactory. On this point a gentleman, who understands the trade thoroughly, very pertinently says that while these veins may be no detriment "to rough work, such as piles, sleepers, and the like, which will stand gum patches in moderation, they will not do in high class machine worked boards or scantlings." In his judgment, which is confirmed by the opinion of others "where gum is concentrated in large patches, the tree has bled from cause of injury probably," a fact that the expert to whom I refer, would readily admit. This, however, is the conclusion of the matter, "if," says my friend, "the superior merits of Eucalyptus timber depends upon signs of gum, it will take a lot of selling in this country."

But as a further proof of the necessity of an improvement in the "working practice" to which I have referred, take another illustration. In the judgment of a municipal engineer of Queensland, who has written a paper on the subject, and should therefore know something about it, to season Australian timbers properly, they should be immersed in water for 14 days to dissolve the sap, and afterwards be allowed to dry in the sun! Such an opinion needs no comment.

I could submit a number of further proofs of the necessity of careful consideration of these matters, if required, but I will content myself with one concluding piece of evidence. A gentleman, who has had more years' experience in the timber trade than he cares to count, and who knows a good deal about Australian timbers, writing me on the subject of my paper, advises that the attention of those who are interested in the timber industry of Australia should be confined, for the present, to a few of the better known woods, such as Western Australian Jarrah and Karri; Victorian Red Gum, Grey Box, and Forest Mahogany; New South Wales Blackbutt, Tallow-wood, Turpentine, and Spotted Gum; and Tasmanian Blue Gum and two or three other varieties. He then says, "I cannot too strongly warn intending shippers from sending supplies to the European markets unless carefully selected and prepared by an experienced man, well-versed in the requirements of such markets, as a carelessly selected and badly prepared shipment of a new species of wood not only entails most serious loss to the producer, but creates a prejudice against the wood itself, which will take years to remove, however good future shipments may be." He then furnishes an instance of this in regard to Tasmanian Stringy Bark, which he considers an excellent timber, if properly treated. He further says that he regards "ring-barking as advisable in all cases; and if scantlings are to be cut, it is essential. All the Eucalypts are to a certain extent evergreens, but the growth is practically quiescent in the autumn and early spring, say from April to August. It is, therefore, during these months that the trees ought to be ring-barked, and they ought not to be felled for 15 or, in the case of large trees, 18 months afterwards. On no account must the tree be felled whilst green, and allowed to dry on the ground." He holds that there is no such danger from forest fires, as some Australian foresters appear to think, if the trees be ring-barked, seeing that in many of the forests there is little undergrowth, while ring-barked trees of the nature of Eucalypts cannot, in so short a time, be rendered "bone-dry." He is of opinion that all timbers to be used for piles should have the heart "boxed," and that the trees chosen should be as small as is consistent with the dimensions of the piles required. He calls attention to the fact that, in a recent contract for piles, 90 ft. to 100 ft. long by 18 in. square, it was stipulated that the bottom of the pile, which of course is the top of the tree, should be without wane or rounded edges. This condition necessitated the selection of trees of immense diameter, some of which were past their prime, the heart wood near the butt being inclined to be "spongy." He considers that had some latitude been given as to wane at the top, trees in their very prime condition could have been secured, labour and waste saved, and stronger piles would have been supplied. He concludes by saying that the best wood of Australian Eucalypts is not near the heart, which is well-known by those who have any experience with this class of timber, and that, therefore, all scantlings should be clear of the pith by, at least, three or four inches, and that as wood invariably shakes in the direction of the medullary rays, and across the annular rings, all scantlings should be sawn on the quarter.

Some of these points are, of course, matters of common knowledge to those who are familiar with the trade. But they, with others relating to the methods of production and business, to which I have alluded elsewhere, are certainly worthy of careful attention.

In conclusion, I would respectfully submit—

First, that importers and users of timbers in Great Britain and Ireland should be prepared to give favourable consideration to the claims advanced on behalf of the woods of all British Dependencies, and should be willing, in order to encourage the trade of Greater Britain, to make some sacrifices, if necessary, for this purpose. Take, for example, our railway companies. It is well known that hard wood sleepers will far outlast soft wood, and that, indeed, for durability there is nothing like them. Should not these companies, therefore, be willing to consider the question of adopting these woods, even if the prime cost is greater to begin with, than the softer woods to which they have been accustomed? It has been suggested that it would be well for them to inquire into the advisability of doing away with "chairs" on their permanent way, in view of the fact that most of the Continental and all the Australian and American railways have done so to the alleged economical advantage of the system. Were such a course adopted a considerable extension of the use of Australian sleepers would be likely to ensue.

Second, that the British Government should do its part to assist the development of trade within its own dominions, (1) by careful inquiry as to the timbers grown in Australasia, Canada, and other Dependencies of the Crown, suitable for its public works and for naval construction, and (2) in every case where such timbers can be economically employed, by specifying them. I have recently heard some strong things said about the action of the British Government in ordering railway sleepers for South African railways from Europe, when sleepers of a better class and at very moderate prices could have been obtained from Australia. It has been thought that, in view of the sacrifices which Australia has made on behalf of the Empire, she deserved a little better treatment.

Third, that the various States of the Australian Commonwealth, or better still the Federal Government, should concert measures for (1) the conservation, management, and development of the forest resources of each state; (2) the classification, naming, and testing of all timbers available for export; (3) the provision of all necessary internal transit and other facilities, in order to assist millowners, and others interested, in the development of the timber industry in each State, and to encourage them to expend more capital upon it; (4) the organisation of a Bureau in the City of London, where samples of Australian woods may be inspected, and where the fullest information in regard to all timbers available for export may be obtained.

As to the question of *the conservation, management, and development of the forest resources of the various States*, there is no doubt, if they are to become a permanent, not to say an immediate asset, the measures necessary must be adopted. On this point Professor Schlich, in his paper, said: "Surely the time has come, or rather it came some time ago, for a more vigorous forest policy, on sensible lines, throughout the Empire. Let us strive to introduce systematic forest management, more particularly into Canada and Australasia. The question is no doubt beset by great difficulty, but where there is a will there is also a way. Above all, let the self-governing Colonies consider the magnificent example which has been set them by India, where the preservation of the State forests has now been put on a safe basis, for the everlasting benefit of the people of the country and the Indian exchequer." I am glad to know that Dr. Schlich's idea is likely to be carried out in some measure. The able report of the Victorian Royal Commission refers to the action of the East Indian Government, and to the need of a similar course being adopted in Australasia. In other States, besides Victoria, the question of the forests is also receiving increased attention. Efforts are being made to check the lamentable destruction of valuable timber, which in the supposed interests of land settlement and agriculture has been going on for so many years, a destruction which has been characterised as unnecessary and even wanton. In this respect, we are all offenders, and offenders against light and knowledge. In 1878 Mr. Julian C. Rogers, the Secretary of the Surveyors' Institution, wrote a most informing paper on the subject of Colonial Timbers, which was adopted as a Government paper and circulated under Government authority. In that he said, "The returns exhibit, in a striking manner, the urgent need for some prompt and comprehensive action to stay the influences at work to destroy the indigenous forests which constitute, in many instances, the principal natural riches of the Colonies. There is a tendency in newly settled countries to regard the timber as a mere encumbrance to the land, and as it generally occupies the most fertile soils, the finest timber is that first selected for destruction." Had the information given, and the advice tendered so long ago received the attention they deserved, the condition of the forest resources of Australia and other British Dependencies would have been very different from what it is to-day.

As to *the classification, naming, and testing of timbers* available for export, the enumeration of the various trees with their diverse and confusing nomenclature, which has formed so large a part of this paper, the varying opinions prevalent as to the comparative strength of Australian timbers shown in the strangely contradictory tests that have been published, and the uncertainty in which the question of the supply of suitable timbers for export is involved, render this suggestion timely and necessary.

The same may be said of *the provision of internal facilities for the development of the timber industry of the various States.* Those who know anything of the difficulties with which the millowners of Australia have often to contend will heartily endorse this view.

As to the establishment of a Bureau in the City of London, I think it will be admitted that, while the display of Australian timbers at the Imperial Institute is an excellent thing, from an educational point of view, neither that nor the supply of information at the disposal of the separate Agencies will so well meet the requirements of the trade, as the establishment of a central Bureau in the City, where samples of Australian timber can be inspected, and the most up-to-date information can be obtained by engineers and others, who are only waiting the opportunity to help forward the interests of Greater Britain.

These are matters which, in my judgment, are worthy our attention, and the attention of the Governments of the various States of the Australian Commonwealth, as by their adoption, the permanent interests of the timber industries of those States would be promoted, and a large and profitable trade with the United Kingdom and the Continent of Europe be secured.

APPENDIX.

(1). The following are the timbers referred to in this paper, alphabetically arranged according to their common names :—

Badjong
Bairnsdale Grey Box.
Bastard Ironbark.
Black Bean.
Blackbutt.
Blackwood.
Bloodwood.
Blue Gum.
Brown Pine.
Brush Box.
Beechwood.
Cypress Pine.
Evergreen Beech.
Flooded Gum.
Forest Mahogany.
Grey Box.
Grey Gum.
Hoop Pine.
Red Bean.
Red Cedar.
Red Gum.
Red Mahogany.
Sandal Wood.
She Oak.
She Pine.
Silky Oak.
Silver Top Ironbark.
Spotted Gum.
Stringy Bark.
Sugar Gum.
Swamp Gum.
Swamp Mahogany.
Tallow Wood.
Tuart.
Tulip Wood.
Turnip Wood.

Huon Pine.
Ironbark.
Jarrah.
Karri.
Lightwood.
Messmate.
Mountain Ash.
Murray Red Gum.
Myrtle.
Paper Barked Tea Tree.
Pencil Cedar.
Peppermint.
Raspberry Jam.
Turpentine.
Wandoo.
Wattle.
Wattle Gum.
White Beech.
White Gum.
White Ironbark.
White Mahogany.
White Pine.
Woollybutt.
Yate Gum.
York Gum.

No attempt has been made to classify these under the head of the different States, as, in many instances, they are common to them all.

(2). The following Table, from the Victorian Royal Commission's report, shows the average life of Australian sleepers. This material is usually cut from green trees and is merely stacked for a short time in the forest or along the lines before being laid down in the track, but no preservative process is employed.

State and Gauge.	Shape.	Timber used.	Cost.	Life in track.	Order of merit.
Queensland, 3 ft. 6 in.	Hewn rectangular and sawn half round.	Ironbark, tallow-wood, spotted gum, red stringy bark and blood-wood.	£7 to £7 12s. per 100; 1s. 4¾d. to 1s. 6¼d. each.	15 to over 30 years.	As used.
New South Wales, 4 ft. 8½ in.	Rectangular, 9 ft. × 10 in. × 5 in., main lines; 8 ft. × 9 in. × 4½ in. branch and pioneer lines.	Hewn ironbark.	2s. 11½d. to 3s. 6d. (9 ft.); 1s. 9d. to 2s. 6d.	Average 25, max. about 35 years.	Ironbark (grey) murray red gum grey gum, gre box.
Victoria, 5 ft. 3 in.	Rectangular, 9 ft. × 10 in. × 5 in.; 9 ft. × 9 in. × 4½ in.	Sawn and hewn red ironbark, red gum, grey box.	10 in. × 5 in., 2s. 11d. to 3s. 6d.; 9 in. × 4½ in., 2s. 5d. to 3s.	24 to 30 years. 18 to 30 years.	Grey box and red iron-bark equal; next red gum.
South Australia, 5 ft. 3 in.	Rectangular, 8 ft. 6 in. × 10 in. × 5 in., formerly 9 ft. × 9 in. × 4½ in. and 8 ft. 6 in. × 9 in. × 4½ in.	Sawn South Australian red gum, blue gum, white ironbark, sugar gum, grey box, and West Australian Jarrah.	4s. 11d. to 5s.	3 to 25 years. Life varies greatly with quality of timber and condition of ground; in northern parts subject to white ants.	South Australia red gum and blu gum, and We Australian Jarra first; South Australian sugargu and grey bo second.
3 ft. 6 in.	Rectangular, 6 ft. 6 in. × 8 in. × 4½ in.	...	2s. 5d. to 3s.	...	...
West Australia, 3 ft. 6 in.	Rectangular, 7 ft. × 8 in. × 4 in.	Sawn and hewn Jarrah.	1s. 2½d. to 1s. 4½d.	Not known. In wear 17 years.	Jarrah and Wandoo.
Tasmania, 3 ft. 6 in.	Rectangular, 6 ft. 6 in. × 9 in. × 5 in.	Stringy bark, blue gum, peppermint (for mountain ash)	1s. 2d.	Average 14, max. 25 years.	Blue gum, string bark, peppermin

Hewn sleepers are regarded as better than sawn sleepers by some authorities.—E.T.S.

3. In addition to the forestry and other reports issued by the Governments of the various States and the works referred to in this paper, the writer has made use of Mr. F. Manson Bailey's book on "Queensland Woods," Mr. Arvid Wilson's book on "The Timber Trees of New South Wales," the catalogue of "The Economic Woods of Victoria," issued by Mr. J. Cosmo Newbery of the Public Library, Melbourne, and other works dealing with the flora of Australia.

DISCUSSION.

The CHAIRMAN, in inviting discussion on the paper, said he was glad to have had an opportunity of presiding and listening to the treatment of such an interesting subject as that which had been dealt with by Mr. Scammell; and the more especially so, as he had during the last week been engaged hearing evidence as a member of a Commission on Forestry. The timber supplies of the world were, of course, a matter of the greatest importance at the present time, as there seemed to be indications that the forests were giving out. They could judge that by the fact that timber of smaller and inferior character was sold in this country now, that in times gone by would not have obtained a market. The resources of Australia must be of great importance, as our supplies of timber for works of construction appeared to have been chiefly drawn from the temperate zone of the Northern hemisphere while from the Southern parts, very little had been obtained, except for making furniture and for ornamental purposes. As to how far Australia and New Zealand could take the place of America and the Baltic, was a point of the greatest interest and importance. In one direction, as the author had mentioned, Australia had supplied us with a very valuable product for paving purposes. All the great centres of population had now made up their minds that they must look to the forest, rather than to the quarry, in order to run the traffic over the various streets. He hoped that in future ratepayers would expend their money in purchasing materials from countries which re flying our own flag, rather than from countries ose jealousies seemed to be inspired by trade alry. He was sure that Mr. Scammell's paper had me at a very opportune time, and he (the Chairman) ve him his best thanks for the addition that he d made to the present knowledge of the subject.

Mr. **James Stirling** said, as an Australian resid- g temporarily in London, it was an especial ivilege for him to be able to attend a meeting of e Society of Arts and hear such a paper on one least of the natural resources of our Australian rritories. Having had opportunities during any years of travelling through South Australia, ew South Wales, and Victoria, and knowing the stribution of the eucalyptus vegetation, it was tremely interesting to him to have listened to the marks made by Mr. Scammell, more especially with gard to the possibility of a large export trade that particular product. One point he wished refer to, was that of nomenclature. In all scriptions of that kind he thought it would better to retain the correct botanical me than to use the ordinary vernacular. For stance, there were various kinds of white gum trees, t they had distinct qualities both with regard to rability and general use. Then there were several the ironbark kind, and at least half a dozen species stringy barks. In each of the States it would be und that there were a number of restrictive species. he late Baron Von Müller, who stood pre-eminent the most distinguished botanist of the Southern misphere, had given a monumental work to the olonies in a complete description of all the calypts of Australia. Baron Von Müller had ld them that there were over 130 different ecies there, and of that number Western ustralia claimed 70 per cent. of the restrictive ecies. That point appealed strongly to them when ey considered the question of nomenclature. In ondon people heard of Jarrah wood and Karri wood. he former was restricted to Western Australia, yet was only the other day that he heard of a Jarrah ood from Queensland. Such a description as that hich was usually given was distinctly confusing. here were certain species of blue gum and certain of d gum, and both were known as valuable timbers. he terms "red" and "blue," however, were pplied indiscriminately to timbers which had not the articular properties of the two species to which he eferred, viz., those of Tasmania and Victoria. r. Scammell specially referred to the timbers of ew South Wales, which he said represented the prin- ipal timbers of Victoria and Queensland. No doubt any of the eucalypts found in New South Wales were lso found in the north-eastern territory of Victoria. urning to the portions of the Commonwealth which roduced most of the trees, Mr. Stirling said that in he sub-Alpine areas the most densely afforested egions were found. The trees were closer together han they were in any other part of the country. Some of the same type came down from Queensland into Victoria, while others came from even Western Australia and South Australia into Victoria. The point he wished to bring forward was that there was such a great variety of eucalyptus vegetation that different qualities were shown even in one species only. For instance, they might get a timber called red gum, which was not the proper eucalyptus of Victoria, but yet which was valuable for paving, just as much so as the Jarrah of Western Australia.

Mr. **J. P. Barber** (Borough Surveyor of Islington) said he was glad Mr. Scammell had marshalled together such an enormous amount of reliable and accurate information. Touching upon the energy exercised by those who had represented timber exporters, he remarked that those gentlemen had been exceedingly energetic in introducing Australian timbers. Unfortunately, however, they were not scientific men, and the information which they had disseminated had probably not been information which was strictly accurate from a scientific point of view. Some years ago when Australian timbers were first used for street paving, a controversy arose as to the respective merits of Jarrah and Karri. Those timbers were being sold by rival dealers, and attempts were made, though hardly scientific, to bring forward their respective qualities. He thought engineers and those who were in need of information respecting good and sound Australian timbers, ought to be very much indebted to Mr. Scammell for his paper. Referring to his (Mr. Barber's) experience, he mentioned that more than 12 years ago, when Jarrah timber was first brought to this country, it was used for wood-paving in King's-road, Chelsea. Later on, Karri timber was brought over here, and he and others were surprised to find that a portion of the trial strip of timber he had referred to was partly Karri and partly Jarrah. The result of all this showed him that the rivalry between the exporters of Australian timbers must to some extent have prevented a more extensive use of those timbers. Those who had been desirous of ascertaining the respective merits of the timbers before using them must have been put in a dilemma and must have felt not quite certain what timber they ought to adopt. Happily in his parish of Islington they had learned something by the use of the various timbers in experiments that they had made. Undoubtedly there had been failures in some Australian timbers, but as the author of the paper had said, no doubt the failures were largely due to the improper seasoning and the treatment and the selection of the timbers which had been sent over here. One particular class which had puzzled him very much was Karri, which was certainly good for paving streets. He could only speak of it from that point of view, but while some parts of the streets paved with Karri had given him great satisfaction, in other places there had been disappointment owing to the enormous amount of shrinkage which had taken place. Blocks which had been put down apparently in a good sound condition had in less than six months shrunk so as to leave joints varying from half an inch to five-eighth inch in width. That certainly was not satisfactory. After testing both Karri and Jarrah he had come to the conclusion that Karri was given more to expansion and contraction than Jarrah. About five years ago he made a trial of all Australian timbers which had been brought to his notice for street paving. He was anxious to get for the ratepayers the very best timber he could, so the only way to find that out was not so much to listen to representatives of the exporters or importers and those who secured orders, as to lay down trial strips and judge for one's self. He was somewhat disappointed in the number of different woods he obtained, because he had expected from the literature which he had seen, and the appeals which had been made to engineers generally, that there would be no difficulty in obtaining what he desired. He was glad now to find that Mr. Scammell had named the timbers upon which the various municipal bodies could rely for the purposes of paving. He was further pleased to see that the question of a bureau or museum was suggested, as it would help engineers and authors very materially towards the selection of the best qualities. Referring to Mr. Scammell's remarks as to the method of seasoning hard wood, he was afraid a great amount of damage had been done to the reputation of the timber by its being sent over in a condition which was certainly not fit for use. If timber from British colonies was to be used, the trade ought to be carried on in a truly British and straightforward way, and they ought to be informed as to which was the best material upon which to rely.

Mr. K. C. RICHARDSON, said he heartily joined in the expression of thanks for the very able paper read to them. He intended to make a few remarks upon the botanical question, but when he saw Mr. Stirling present, he knew the subject would be most ably dealt with. Referring to Mr. Scammell's use of the word "box," he reminded them that they must not think it meant the "box" that was used in this country. The only "box" that Tasmania produced, was a small tree, which certainly might be used in a very useful manner, but not in the way in which it was in this country. He thought he would mention that in order to prevent the word conveying a false impression. The eucalypts had several characteristics. For instance, the gum top had the characteristics of both the blue gum and the stringy bark, and there was some divergence of opinion as to whether or not it was a distinct kind of eucalypt. Anybody who contracted to use blue gum or Tasmania stringy bark would find that they would not care about the gum-topped variety. As a wood, whether hybrid or not, it was totally distinct from blue gum or stringy bark. It could not be too much insisted upon that the best wood should be sent to the London
market. He paid a great deal of attention to t
last speaker (Mr. Barber) whose difficulties he cou
quite understand. How were they to avoid shrinkag
His experience taught him that the only way w
by properly ring-barking the tree and not fellin
it until it had been gradually killed. His forest
experience dated as far back as the early sixtie
that, however, was in the West Indies. Aft
the tree had been properly killed, that was
say slowly bled to death, it ought to be felled.
to how it should be cut up, he suggested that eve
scantling ought to be cut on the quarter, some tw
or three inches from the heart. The reason was th
the heart of the eucalypt was not the best part of th
wood. It ought also to be cut clear of the sap woo
That was the more essential, because, in the soft
wood, near the pith, there was always shrinkage.
good time for it to remain would be fifteen mont
after being ring-barked, and the result would be th
there would be a fair chance of the wood standin
well. With reference to paving blocks he must con
fess that the blue gum and stringy bark would not
because of the shrinkage, which was much great
than either Karri or Jarrah. True, the form
had their good uses and could be produced at
lower rate. The chief factors besides the in
proper preparation of Australian wood that ha
led to the difficulty of its becoming popular wer
firstly, the cost of transport. On that hea
Mr. Scammell had alluded to a shipping combin
He (Mr. Richardson) suggested that timber pro
ducers ought to club together and purchase old
fashioned vessels in which to send the wood. H
felt that this would prove profitable. He gave a
instance in this respect by saying that he knew of
vessel which was bought for £2,000, and the workin
of it with stores and everything came to only £1,200
The total was £3,200, and he could assure his hearer
that that vessel earned in nine months, on a homewar
voyage no less than £2,900. An enormous amount o
money was put into this timber industry, but up to
the present there had been no very good results to the
shareholders, taken as a whole. He suggested tha
a great deal better results would be obtained by a
few hard-working Englishmen, who possessed a few
thousand pounds, clubbing together, going into the
forests, and utilising the by-products and various
classes of timber. It cost a great deal of money
to open up the Australian bush, but if they set their
minds to it they would find other things besides
timber, and could make the venture pay well. In
conclusion, he said they ought not to confine themselves to one particular wood, but take whatever could be found, and turn it into commercial value.

Mr. ALEXANDER HOWARD remarked upon the introduction of the Australian woods into the markets of Great Britain, and said that the use to which it could be put was one of the most important things to consider. He had used all kinds of timber for a considerable period, and could not help admitting that the Australian woods were magnificent, and might be vastly used in the distant future. He could not, however, imagine that they would be utilised to a very great extent in the near future. It was undoubtedly well produced, and some of it was sent over here in a much better condition than most of the hard woods imported from other countries, but he was doubtful whether the method of sending Australian woods here was going to assist in the increase of the importation. Immense sums had been spent in introducing Jarrah and Karri into London, but engineers, architects and others did not seem to care for it while they could get such wood as oak and mahogany for their requirements. Another drawback against certain Australian woods was the fact that spikes and nails could not be driven in, whilst another was the great tendency to expansion and contraction. The last-named rendered it impossible to utilise it for cabinet making or joiners' work in England. Further, the length of time required to season it was a drawback, and, lastly, the cost of production and freight was exceedingly great. If that condition of things could be brought about by which the Government would take an intelligent view of this particular trade, undoubtedly they would arrive at a better state of things in regard to it. Otherwise, people would continue to do the plain business thing which they had done hitherto, namely, buy products in the cheapest market and under the cheapest circumstances. For those reasons he did not see that there could be large supplies from the colonies in the near future.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Scammell, said that gentleman had made a valuable addition to the knowledge of this important subject. The only criticism he had to make with regard to the discussion was that it was more given to details than to general principles. Undoubtedly by far the largest part of the importation of timber to this country was from the pine and spruce woods of Northern Europe and North America, and on that point he would ask Mr. Scammell to say whether he considered there was any wood in Australia or New Zealand which could take the place of the deals imported from the Baltic and North America? Of course, for the purposes of paving, the Australian woods were very largely used nowadays. In view of the North American and North European forests being so greatly drawn upon, the supply must soon show signs of exhaustion, it therefore became necessary to enquire as to how far we were able to draw upon Australia and New Zealand.

The vote of thanks was carried unanimously.

Mr. SCAMMELL, in reply, said he was glad they had had such an excellent and representative discussion, especially by such gentlemen as Mr. Stirling, who represented the Victorian Government; Mr. Barber representing the municipal engineers of London; Mr. Richardson, a most practical man, who knew much about Australian woods; and Mr. Howard, who was one of the leading timber merchants in the City. He quite agreed with Mr. Stirling's remarks as to nomenclature. Mr. Barber's observations were very much to the purpose, and were very interesting, both with respect to Karri and Jarrah, and other woods. He was glad that he and Mr. Barber agreed on the matter of necessity of tests, and he hoped the Government would cause such tests to be made as would result in benefit, and be of great value to engineers and the public generally. Mr. Howard had spoken his mind very freely, and with reference to his observations he (Mr. Scammell) would like to say he claimed that Australian woods were specially fitted for certain classes of work in this country, and it was ridiculous that the bill for the importation of that wood amounted to only a few hundreds of thousands sterling out of the many millions which were spent in the importation of timber from other countries. On the point of the durability of Karri and Jarrah for wood paving, he would point out that fair tests had been made. The wood was used not only in many parts of London, but in a large number of provincial towns, and the greatest satisfaction had been expressed, especially where the Karri and Jarrah had been properly seasoned, properly laid, and properly supervised. As to the cost of bringing the wood from such a great distance as Australia, that was a matter that required further consideration. The Governments of Australia and those concerned in the exportation of the timber ought to be impressed with the fact that they should carefully consider the whole question, put their shoulder to the work, and decide upon sending the exact kinds of timber required over here. Then he felt sure that the proper information would be laid before engineers and others in such a form that they would know what to do. So far as the Chairman's question was concerned, he must reply that he did not think any of the pine woods of Australia could compete for a moment with European or Canadian pines.

Dr. W. SCHLICH, C.I.E., writes:—Mr. Scammell's paper has brought an important matter before the members of the Society of Arts. As regards the forest question generally, and the timber supply of the Empire in particular, Canada and Australia demand our special attention. Mr. Scammell's objects are to show that considerable stocks of various useful timbers are available in Australia for export to this country and elsewhere, and to bring about a further development of the existing exports. While heartily wishing him success in the latter respect, I sincerely trust that the Governments of the several Australian Colonies will, without further delay, take the necessary measures so as to secure a permanency of the trade, and not be satisfied with a temporary development, followed by the ruin of the still existing forests.

From a general survey of the data at my disposal, it appears that only about 10 per cent. of the area of Australia are under timber forests, and enough has been said and written to show that these are on the highway to ruin. "The Commission on State Forests and Timber Reserves," appointed by the Parliament of Victoria in 1897, clearly shows that the Australian States are still playing with the forest question. While the splendid forests of eucalypts and other trees are, in many cases, for temporary political reasons, allowed to be ruined, the Legislatures quiet their consciences by establishing puny plantations of exotic and indigenous trees. Surely they would do better to look after the existing forests, and thus perpetuate a supply of timber and other produce for home consumption and export. What is really wanted, and urgently wanted, is:—

(1). To select in each State a sufficient area of permanent State forests, and to put them under a system of efficient protection and management, and

(2). To remove these State forests from the vacillating influence of party politics, by rendering them inalienable, except for special and important reasons.

These measures need not for a moment interfere with the maintenance and further development of the timber trade, because the formation of State forests does not mean shutting them up. No doubt considerable areas have been leased away, but enough remains to carry out the policy indicated above.

Another point to which I should like to draw attention is the ridiculously small revenue which the Australian Government derive from this important State property. Taking, for instance, Western Australia, it is said that the total forest area amounts to some 97,000,000 acres, of which about 20,000,000 acres are stocked with marketable timber. In 1899 the exports of timber were valued at £583,000, while the revenue paid into the State treasury amounted to £17,000. This is not the way to dispose of State property which belongs to the community as a whole. Let everything possible be done to develop the trade in timber, but let the State have a fair share of the profit, wherewith to introduce a rational treatment of the forests and to insure their permanent yield capacity. Several of the Australian timbers are so valuable for a variety of purposes, that a steady demand is sure to arise and be kept up. As regards one class of utilisation, I am, however, somewhat doubtful. Great efforts have been made to convince people that Jarrah and Karri are the best timbers for street paving blocks, and in all probability they are. At the same time, I believe, that the solution of this question lies elsewhere. My personal opinion is, that as soon as motor cars of various sorts have seized upon the traffic in our towns, the Corporations will once more lay down asphalte, pure and simple, as the most suitable, and at the same time, the best paving material from a hygienic point of view.

Miscellaneous.

*TRADE AND TARIFF WITH CHINA.**

The revision of the tariff with China is in Shanghai just now the great question of the day, the interest involved is very great, consequently the whole matter should be well thought out or an irretrievable mistake will be made.

Sir James Mackay, the Tariff Commissioner, advocates a 15 per cent. import duty and abolition of Likin dues, which is considered a monstrous innovation. On the fact becoming known the China Association called a special meeting to discuss the matter and protest against the scheme; the opinion of the commercial community is with the China Association. The following resolutions were carried by a large majority:—

"1st. That this meeting deprecates any agreement being entered into with the Chinese Government involving any increase of the present rate of import duty, viz., 5 per cent. *ad valorem*, whether subject to the abolition of all Likin or not, as judging by past experience any pledges given by the Chinese Government could not be held to be an effective guarantee of their fulfilment.

"2nd. That whilst viewing with disfavour the system of Likin, and recognising the difficulties attending its immediate abolition, it is expedient to obtain safeguards against any increase in the said tax as at present levied, and to urge the Chinese Government to reform and regulate the collection thereof whereby the provincial treasuries may be more directly benefited."

These resolutions are plain and to the point, passed by a body of business men, who know what they are talking about; they also know the character of the general run of Chinese officials and their shuffling ways, people with whom they have dealings.

In the face of all guaranty and assurance hitherto given, it is a well-known fact that no treaty with China, applying to trade, duty, &c., has ever been observed, and it will be difficult to convince those who know the Chinese official well, that he is in any way altered.

There can be no substantial guarantee that Likin would be entirely abolished, even though the import duty was raised to 15 per cent., until the country is reformed.

The viceroys and governors of provinces levy taxes at will, so whatever may be the tariff arrangements, they will be effective only so far as they are in the hands of the Imperial maritime customs.

A few days ago, we were told that the Chinese Tariff Commissioners informed Sir James Mackay that they would not agree to the four following articles:—1st. The import of salt; 2nd, the export of rice; 3rd, the opening up of the interior of China to oreign trade; 4th, the conversion of Peking into treaty port. Certainly what we here would expect nowing them as we do.

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* Communicated by Mr. J. Mobsby, British Admiralty Pilot on the Yangtse.

What should be demanded before we venture on a cheme that may hamper our trade beyond recovery? The Chinese Government must show clear evidence of iscal reform, respect for treaties, and general good government.

It must be remembered we are still dealing with a reactionary Government; it is only on compulsion by the growing will of the people for reform, and the wise counsel of the two Yangtse Viceroys, Lui-Kunzi and Chang-chi-tung and Yuan-shih-kai, Viceroy of Chihli, that they in any way lean to reform. These few enlightened officials evidently see the necessity for it, and having been induced to start off on the lines of progress we should wait and let them work out their own salvation, which they will do if left alone. The Likin has already been put in the hands of the Imperial maritime customs in some districts at and near the treaty ports, and will doubtless gradually extend; when the whole Likin in China is properly accounted for they will require no financial aid from outside. China's liabilities are small indeed compared to the vast wealth of this great empire. Well may it be asked why foreign trade should be called upon to pay for all China's misdoings in the past.

Three new treaty ports are supposed to be opened to foreign trade this year. They are Nganking, in the Province of Ngan-wei, 370 miles up and on the left bank of the Yangtse; Changsha, the capital of Hunan Province, on the Siang river, which runs into the Tungting lake at the south end; Changteh, an important trading centre to the west of the Tungting lake on the Yuen river. The latter port will probably be the most important, being a connecting link for trade between Hankow and Chungking, by which route there is already considerable native junk trade.

If China is not to be opened up generally to foreign trade, then let us at least get into the country as far as the waterways will admit. Nan-Chang, the capital of Kiangse Province, is a very important trade centre. It is situated on the Kan River that runs in the Poyang Lake at the south end; it is distant from Kuikiang about 120 miles nearly south, and should be opened to trade.

Since the signing of the Peace Protocol on September 7th, 1901, events are moving apace. Colleges and schools are being set up in some of the chief cities of the Empire for Western learning, principally English. The native press strongly advocates reform on British lines, quoting Egypt as an example.

Railway and mining concessions are attracting considerable attention in the Yangtse Valley and other parts of China. It is more than likely the Chinese will form companies to carry on these works. The high officials of Shansi and Shensi Provinces are encouraging such undertakings.

The conservancy scheme for the Whangpu River as agreed in the Peace Protocol is taking concrete form, this will greatly facilitate trade to and from Shanghai where British interests are very large and growing rapidly.

The buoyage and lighting of the Yangtse and its approaches are receiving considerable attention just now.

Steam traffic on the coast of China is steadily increasing, about twenty new steamers, chiefly British, are being added to the already large fleet employed.

In any new treaty that may be made where trade facilities are considered, the system of river pass on the Yangtse should be abolished, for it is altogether an absurdity, causing great delay to shipping entering and leaving the Yangtse, with no object gained. The Yangtse regulations require considerable alterations to make them uniform and workable.

Trade has started off very briskly with the opening of the northern ports; altogether the outlook for trade with China is daily improving.

The events noted above have received great impetus from the fact of greater security given to trade by the Anglo-Japanese convention, which is probably the very best our much abused Government could have done for our commercial interests and the integrity of China, which is paramount to all other questions in the far East.

THE FORESTS OF RUSSIA.

The gradual deforestation of Russia is attracting increased attention throughout the Empire, and the Forestry Society as well as the Forestry Department of the Ministry of Agriculture and Domains are discussing means for regulating the consumption of timber and for propagation. There does not seem to be any great cause, however, for apprehension, as a recent official report states that forests in Russia now cover an area of 188,000,000 hectares (464,000,000 acres). Among European countries, Sweden comes next with 44,000,000 acres of forests. In Russia the forests cover 36 per cent. of the whole area of the country. The Swedish forests occupy 44 per cent. of the total area, and the Austro-Hungarian 32 per cent. of the territory of the dual monarchy. Reckoned by the population, there are 4·9 acres of forest to each inhabitant of Russia, 9·5 acres in Sweden, 10·4 acres in Norway, and ·69 acre per head in Germany. The forests have a greater importance for Russians than for people of Western European countries, as villages and country houses are largely built of wood, stone and brick houses being almost unknown, and the forests furnish the main sources of fuel supply.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesdays:—

MAY 7 (8 p.m.).—"Origin and History of Carriages." By ALBERT CHANCELLOR, J.P., Master of the Coach Makers Company.

May 14 (4.30 p.m.).—"Boats and Boat Building in the Malay Peninsula." By H. Warington Smyth.

⁂ The attention of members is directed to the alteration of the hour. This meeting will be held in the afternoon, at 4.30 p.m., instead of in the evening at 8 p.m.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

May 8.—"The Past and Present Connection of England with the Persian Gulf." By Thomas Jewell Bennett. Sir Edward A. Sassoon, Bart., M.P., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

May 6.—"The Printing of Modern Illustrated or Decorated Books." By Charles T. Jacobi. Carmichael Thomas, Member of the Council, will preside.

May 27.—"The Decoration of the Pianoforte." By Charles C. Allom.

Colonial Section.

Thursday afternoon, 4.30 o'clock:—

May 29.—"Western Australia: its Progress and Resources." By the Hon. H. W. Venn.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Richard T. Glazebrook, M.A., D.Sc., F.R.S., "Glass for Optical Instruments."

Lecture IV.—May 5.—The telescopic objective—Conditions of problem—Photographic objective—Telephoto lens—Materials other than glass—Line of future advance—Modern glass-making—Tests of optical glass—Nomenclature.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 5 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Richard T. Glazebrook, "Glass for Optical Instruments." (Lecture IV.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Brierley D. Healey, "Recent Blast Furnace Practice."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. S. Brame and Professor Vivian B. Lewis, "The mixed Carbides of Maganese and Calcium." 2. Mr. Oscar Guttman, "Dangerous Chemical Substances."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting,

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. S. Ransome, "Pekin after the Siege."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. M. L. Rouse, "Procopius African Monument of Joshua's Conquest of Canaan."

Tuesday, May 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Charles T. Jacobi, "The Printing of Modern Illustrated or Decorated Books."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. York Powell, "English Kings and Kingship." (Lecture II.)

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Oldfield Thomas, "The Mammals collected during the Whitaker Expedition to Tripoli." 2. Mr. R. Lydekker, "The Wild Sheep of the Upper Ili Valley." 3. Mr. G. A. Boulenger, "A List of the Fishes, Batrachians, and Reptiles collected by Mr. J. ffolliott Darling in Mashonaland, with Descriptions of new Species."

Wednesday, May 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Albert Chancellor, "Origin and History of Carriages."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ p.m. Annual Meeting. Reading of Papers and Discussions.

Entomological, 11, Chandos-street, W., 7 p.m. 1. Professor L. C. Miall and Professor G. Gilson, "A new Cricket of Aquatic habits, found in Fiji by Professor Gustave Gilson." 2. Mr. Edward Meyrick, "On the Lepidoptera of the Chatham Islands."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Anthropological, 3, Hanover-square, W., 4 p.m. Prof. Boyd Dawkins, "Bigbury Camp and the Pilgrims Way."

Royal Archæological Institute, 20, Hanover-square, W., 4 p.m.

Thursday, May 8...SOCIETY OF ARTS, John-street Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Thomas Jewell Bennett, "The Past and Present Connection of England with the Persian Gulf."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting continued. Reading of Papers and Discussions.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. S. Woodward, "Recent Geological Discoveries.." (Lecture II.)

Electrical Engineers (at the House of the Society of Arts), John-street, Adelphi, W.C. 8 p.m. Discussion on the Form of Model General Conditions.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, May 9...Cold Storage and Ice Association (at the House of the Society of Arts), John-street, Adelphi, W.C., 3 p.m. 1. Dr. W. Hampson, "The Rationale of Cooling Phenomena." 2. Mr. R. J. Key, "The Business Side of Cold Storage."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Professor J. Norman Collie, "Exploration and Climbing in the Canadian Rocky Mountains."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 8 p.m.

Astronomical, Burlington-house, 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

Saturday, May 10...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Walter Rayleigh, "Poets and Poetry." (Lecture II.)

Journal of the Society of Arts,

No. 2,581. Vol. L.

FRIDAY, MAY 9, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Wednesday, May 14, 4.30 p.m. (Ordinary Meeting.) H. Warington Smyth, "Boats and Boat Building in the Malay Peninsula."

⁂ This meeting will be held in the afternoon instead of at the ordinary hour of 8 in the evening.

Further details of the Society's meetings will be found at the end of this number.

CONVERSAZIONE.

The Society's Converzatione will take place at the Royal Botanic Gardens, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 p.m.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards will be forwarded in due course. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

An examination in *vivâ vcce* French was held by the Society's Examiner, Monsieur Naftel, at the Birkbeck Institution, London, on the 22nd and 25rd of April, when 41 Candidates presented themselves, of whom 34 passed and 7 failed. An Examination in the same subject was also held by Monsieur Naftel, at the Central Board School, Manchester, on the 29th of April, when 20 Candidates presented themselves, of whom 16 passed and 4 failed.

CANTOR LECTURES.

Dr. R. T. Glazebrook, F.R.S., delivered the fourth and last lecture of his course on "Glass for Optical Instruments" on Monday evening, 5th inst.

On the motion of the Chairman, a vote of thanks to the lecturer for his important course of lectures was passed.

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, May 6, 1902; Carmichael Thomas, Member of the Council, in the chair. The paper read was "The Printing of Modern Illustrated or Decorated Books," by Charles T. Jacobi.

The paper and report of the discussion will be printed in a future number of the *Journal.*

INDIAN SECTION.

Thursday afternoon, May 8, 1902; Sir Edward A. Sassoon, Bart., M.P., in the chair. The paper read was "The Past and Present Connection of England with the Persian Gulf," by Thomas Jewell Bennett.

The paper and report of the discussion will be printed in a future number of the *Journal.*

COLONIAL SECTION.

A paper on "Western Australia: its Progress and Resources" will be read by the Hon. H. W. Venn on Thursday afternoon, 29th inst., at 4.30 o'clock.

APPLIED ART SECTION.

The reading of the paper on "The Decoration of the Pianoforte," by MR. CHARLES C. ALLOM, announced for Tuesday, May 27, is unavoidably postponed.

Proceedings of the Society.

TWENTIETH ORDINARY MEETING.

Wednesday, May 7, 1902; SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., in the chair.

The following candidates were proposed for election as members of the Society:—

Muller, Frank, Oudtshoorn, Cape Colony, Sonth Africa.

Stephenson, James Keddie, The South African and Australasian Supply and Cold Storage Company, Limited, Dock-road, Cape Town, South Africa.

The following candidates were balloted for, and duly elected members of the Society:—

Puzey, Edmund Dunlop, Secunderabad, Deccan, India.

Earp, Francis Salsbury, Ph.D., F.I.C., F.C.S., Kalgoorlie, Western Australia.

Kilner, George William, Ravenscroft, Moss Hall Grove, North Finchley, N., and Great Northern Railway Goods Station, King's-cross, N.

The paper read was—

THE ORIGIN AND HISTORY OF CARRIAGES.

By ALBERT CHANCELLOR, J.P.
(Master of the Coachmakers' Company.)

I have been honoured by a request to say something this evening on the rise and development of vehicular locomotion, and in order to do this as succinctly as possible, I propose from considerations of time and space merely to sketch the history of carriages from their first inception to the present day.

It will be, I think, at once obvious to you why I can do no more than present you with a mere *ébauche* of the subject, for the fact is, it is one contemporaneous, or very nearly so, with humanity; it has its own literature, larger, perhaps, than many might imagine, and it is one which has exercised a most important influence on life in all its complex and multifarious phases.

Like most arts, that of coach-building, though having its rise in those far distant ages of, as Macaulay would call it, "immemorial antiquity," and though having arrived at what we may, I believe, consider as near perfection as any work of mere human agency can attain, has reached this goal not always by continuous progress, but by intermittent bursts of development.

It has marked epochs just as the history of man has them—the first of which may be roughly estimated at about 2,000 years ago, at the time when Rome had passed from the earlier rule of the Consuls to the later sovereignty of the Emperors; the second epoch would seem to be conterminous with the reigns of those Emperors, or during that rise and fall of the Roman Empire, which Gibbon has illustrated in his immortal prose; the third epoch, in some respects the most important, ends so late as the commencement of the 17th century; the fourth terminates about a hundred years later, while the last, notable for those final developments which make carriage exercise the luxurious mode of transit as we now know it, really had its source in the year 1805, when Obadiah Elliott introduced carriages hanging entirely on elliptic springs.

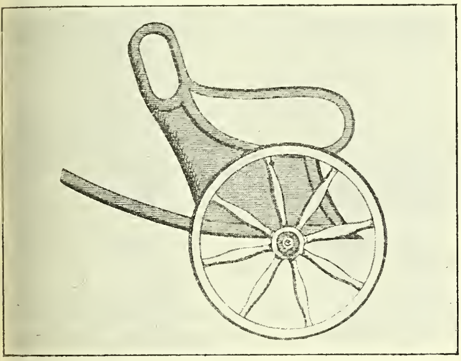
The earliest mode of transit by locomotion was, I suppose, by the means of sledges, and indeed, the first representation of a carriage, if an anachronism may be allowed me, occurs on a sculpture in the Temple of Luxor at Thebes, similar in many respects to those still in use among the Esquimaux, a people which has preserved these early relics of human ingenuity less improved and developed than any nation. We thus see that it was the Egyptians, that remarkable race, who anticipated thousands of years since, the form of transit still in use among an unimaginative and unprogressive race, just as they seem to have anticipated, used, and forgotten half those remarkable inventions which we are to-day struggling to emulate and revivify. Thus too, we find that a little later the Egyptians applied rollers to their sledges, and later still wheels and axles, doubtless incited to these improvements by the necessity of moving the massive blocks of stone which to day, piled one on the other, form those vast pyramids which Napoleon invoked on a memorable occasion, and which remain as the remarkable memorials of a great people to our present wonder and admiration.

Even, now-a-days, carts are made in Spain and Portugal, and some parts of South America, on the same plan as those used by the early Egyptians.

In the temples and tombs of Egypt, that land of past wonders, these carriages or chariots, as the word is translated in the Bible, are represented in various forms; to those interested in this subject they are matters of great importance, for besides shewing us how man was conveyed thousands of years since, they also remain the type, more or less, of all the vehicles of the earliest times.

Besides the innumerable references to carts and chariots in the Holy Scriptures, we have Homer's detailed description in the fifth book of the Iliad, of Juno's car with its "whirling wheels on iron axles," each of which had eight brazen spokes, the felloes of gold being secured with brazen tyres, and its pole of silver, with the golden yoke and reins of gold.

Fig. 1.



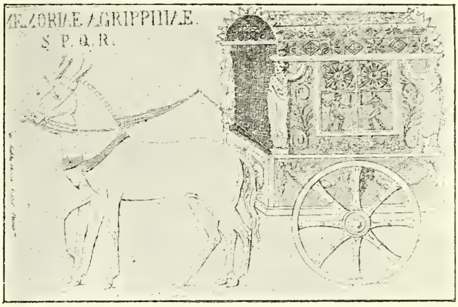
Early Greek Car.

Besides this description, you will remember those few words, breathing the very essence of Oriental magnificence in which Solomon's chariot is sketched for us in the song of Solomon, or Nahum's spirited description of Nineveh's future desolation, "When the sound of the chariots shall be no more, and the feet of the horses for ever still."

It would be I think, superfluous for me here to refer at any length to the chariots and cars in use by the Assyrians, the Persians, or the Scythians and other nations of antiquity, because such chariots and cars as were in vogue among them partake in all the essentials of those made by the Egyptians; it may be, however, noted that those which they used were largely resorted to as a means of locomotion in the battlefield, and were developed in size either in front or behind, as the exigencies of early warfare would seem to have required. We know of course, that this use of the chariot was adopted by the Greeks, for Homer particularly states the fact in his description of the siege of Troy. The Grecian chariots differed from those of the Egyptians, inasmuch as the fronts were carved instead of being flat, and they were more open in build, larger, and placed on higher wheels. They were usually drawn by one or two horses, and Erectheus, one of the Kings of Athens of that name, is said to have been the first to drive four horses together, but as tradition also has it, that Erectheus was killed by Zeus with a flash of lightning at the request of Poseidon, perhaps too much credence should not be given to the story.

The Etrurians are traditionally credited with being the first nation to use a hood or awning over their vehicles, and it was from them that the Romans, as they rose in power and influence, adopted the chariot and car; but, although they did so, it was at first only on State and important occasions. These carriages were rather more elaborate than those previously in use by other nations, of which there are beautiful marble models in the Vatican at Rome. As the advantages of carriages dawned upon the Romans, this use became more general; a two-wheeled cart they used for agricultural purposes, and one with four wheels for religious processions. In their innumerable triumphs a still more elaborate vehicle figured, and a representation of one of them is to be seen on the column of Trajan. It has what was at that time a peculiarity, inasmuch as the two hind wheels are rather higher than the front ones. The earliest record of a covered Roman carriage occurs about 350 B.C., when a four-wheeled conveyance, termed a "Pilentum," is distinctly mentioned as having its seats suspended by straps. The use of these carriages appears,

Fig. 2.

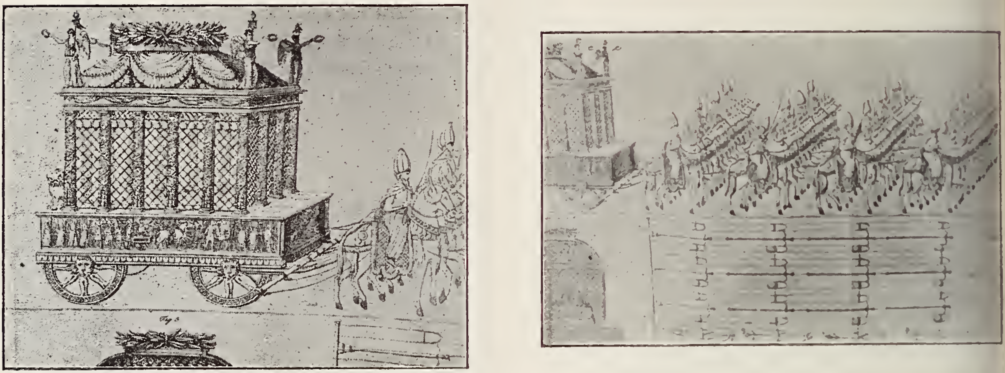

MEMORIAE AGRIPPINAE.
S. P. Q. R.

Carpentum of Agrippina.

however, only to have been conceded as a great favour to a select few. The Empress Agrippina we know had one, as well as a carved vehicle on two wheels, with an arched covering known as a "Carpentum." The various kinds of litters also in vogue in Rome need not, I think, detain us, as although having some relation to carriages properly so called, they can only at best be considered as belonging to cognate subjects.

To those who would study the matter more deeply than I can here unfortunately pretend to do, the pages of Herodotus, and other historians, will provide food for much enquiry, especially as regards the vehicles in use by the Scythians.

Fig. 3.



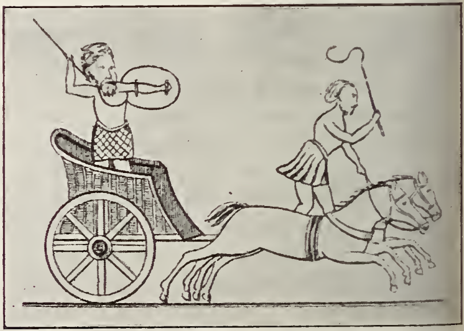
Alexander's Funeral Car, showing 64 Horses.

Alexander the Great would appear to have travelled, on important occasions, in something more resembling the closed carriages of later date, for we are informed that his conveyance was drawn by eight horses, and that it was covered in by a sort of tent. If, however, during his lifetime his mode of transit was thus distinctive, his funeral car would seem to have been still more remarkable. It took two years to build, and was designed by Heironymus, a celebrated architect of the period. It was 18 feet long by 12 feet wide, and rested on four great wheels, and was drawn by no less than 64 mules, eight abreast. The car was composed of a platform, and surmounted by a high roof, upheld by 18 supports, in the form of massive columns; in the centre rested the coffin, surrounded by arms and trophies emblematical of the career of the hero. Many historians have vied in a more or less minute description of its wonders, and there is a drawing of it in Ginzrot's great work on carriages. It would seem to have anticipated those remarkable funeral cars in which the great Nelson and Wellington were carried to their last resting places.

With the second epoch of our subject, we come to the early history of Britain, and the Roman invasion of our island.

England has been long known as the chief centre of carriage building, a fact attested by the number of foreign potentates who to-day come to our modern carriage builders for anything particularly fine; it is therefore fitting, and is a known fact, that when the Romans first landed on our shores, they found, besides many other things, a new form of chariot. This differed from those in use in Rome, and in fact, any of the earlier specimens, in that it was open in the front, instead of being unguarded at the back, it varied also in other ways, which I need not here particularise; that it found more favour with the conquerors than some other products of our land, is evidenced by a letter of Cicero, to a friend who had visited our shores, in which the great orator and writer says "that there appeared to

Fig. 4.



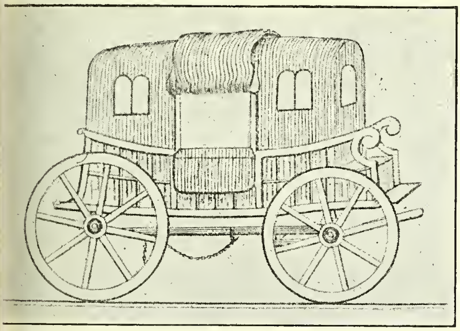
Early British Chariot.

be very little worth bringing away from Britain, except the chariots, of which he wished his friend to bring him one as a pattern," and when Cassivelaunus was carried away prisoner, nothing appears to have created more interest in the attendant triumph than the number of chariots which figured in it and which had been captured from the Britons.

On the Continent, as well as in India and other parts, the genesis and development of cars, chariots and carriages would seem to have progressed on much the same lines as those of the Egyptians and Romans. In the excavations at Pompeii, Sir William Gell found some wheels very like our modern ones, and he also constructed from such-like remains a cart which was used for the conveyance of goods as well as individuals.

Ginzrot in his great work gives an interesting illustration of a primitive Hungarian coach which survived in use to quite recent times; it is not unlike the "Araba" of Turkey, and even those vehicles used by the Boers have still some resemblance to it. In fact, there is little that is distinctive about it, it being simply a sort of disguised wagon with windows and a a door at the side, and were it not for the absence of axle or springs, it might be taken for the rough draft of a much more modern vehicle.

FIG. 5.



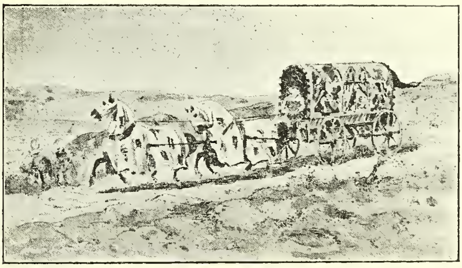
A HUNGARIAN COACH.

I cannot go into the interesting topic of Indian conveyances or those of many other countries which would however repay careful study, as I must continue my slight sketch of carriages in general by saying a word or two on their progress and development in the middle ages and the period immediately following.

It is, indeed, a somewhat remarkable fact that after the fall of the Roman Empire the use of carriages for the conveyance of individuals seems to have been discontinued; a reason, and I think a very pertinent one, has been given for this fact, which is that, after the Romans, the science of road-making fell into such disuse that, even had carriages still continued in vogue, it would have been almost impossible to drag them over the miry, almost trackless ways, which did duty in early times for highways. However, in the reign of Richard II., a time, I may remark, somewhat notable for extravagancies of all kinds, a vehicle termed a "whirlicote," came into use. The King himself had one, and John Stow, the antiquary, particularly mentions them as being used by the king's mother, while one was subsequently used at the marriage of Katherine of Aragon. It would indeed seem as if a general revival in the use of carriages took place about this time, indeed, the rage for such things gained so firm a hold in France, under King Philip, that that Monarch issued, in 1294, a sort of sumptuary law against their use by mere citizens.

A few years previously, Charles of Anjou, on entering Naples, was accompanied by his wife, who rode in what was termed a "caretta," while the Pope, Gregory X., also possessed one. Froissart speaks of them as being used by the English on their return from Scotland, in the reign of Edward III.; and the word itself forms part of that etymological genealogy, which, coming from the Latin Currus, through such cognate terms as car, char, and charette, brings us to the chariot of the early Victorian era.

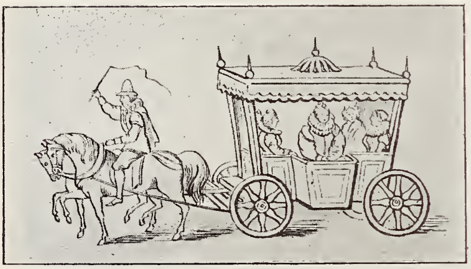
FIG. 6.



A CARRETTA.

In 1553, Queen Mary went to be crowned, in a chariot surmounted by a canopy, and drawn by six horses, while others followed. In form they probably resembled the one used in the triumph of Maximilian I. of Germany, delineated on the wall of the Town Hall of Nuremburg, or more approximately still, that in which Queen Elizabeth is shown in a print by Hollar, to wit:—A carriage on four wheels, open in front, and containing two or three seats with an ornamental covering. A Flemish car, formerly in the Victoria and Albert Museum, would seem to be an improved form of the kind of conveyance used in Queen Mary's time, inasmuch as it is suspended by leather braces, which we have no certain authority for saying were introduced into England at so early a period. As a matter of fact the 16th century was the great time of revival for carriages in Europe generally, and in Hungary it would appear that the art of perfecting them had reached a more advanced stage than in other countries. This is evidenced, I think, by the fact that Ladislaus, King of Hungary, on sending ambassadors to Charles VII. of France, caused them to convey with them a carriage as a present to the French king, which we are expressly told "trembled," probably, from the apparent curiosity aroused by the vehicle, one of the first, if not the first to be suspended by leather straps—that early substitute for springs.

Fig. 7.

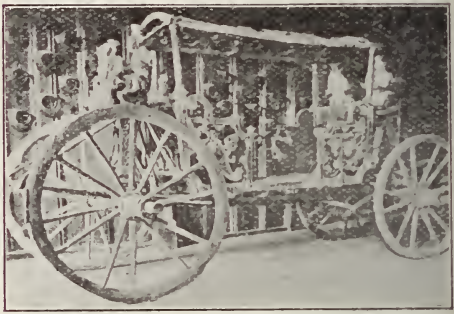


The State Coach of Queen Elizabeth.

It would be at once tedious to you, and unnecessary for me, to particularize all the various historical instances on record in which coaches of one design or another have been used on important occasions, nor is it possible for me to enter into the subject in its more technical bearings, but I may mention that the best authorities have agreed in considering that the German waggon may be regarded as the rough precursor of the gradually developed and improved carriage, so far at least as the lower and more essentially working portion of it is concerned. The method used by the Germans in attaching the pole was, I may parenthetically remark, in all essentials, the same as that in vogue in the early Roman times. To develop this primeval waggon from a mere carriage for agricultural produce to that of human beings was, a natural outcome of the necessity of human conveyance, and so from the hammock slung on the original framework as pictured in an 11th century missal, to the construction of a more elaborate body, was but the work of successive ingenious developments.

These developments would at first take the form of a gradually elaborated and enlarged body to the carriage, such important factors in its construction as springs and general improvements in the framework coming only with time. Something more nearly approximating to our modern conception of a carriage would seem to be one of those old vehicles preserved at Coburg. This particular one was used at the wedding of the Duke John Casimir, in 1584. You will observe that it has leather braces and high wheels, and no doubt there were doors and steps, which have now disappeared. It resembled in many respects the carriage in which Henry IV. of France made his last fateful journey on that May 16th in the year 1610, when the knife of Ravaillac ended his memorable career.

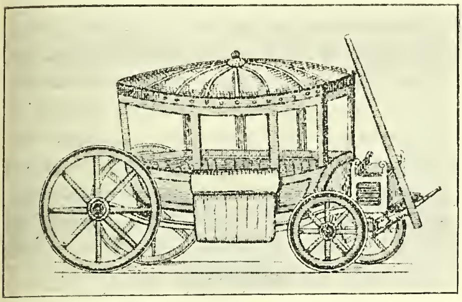
Fig. 8.



The Wedding Coach of Duke Casimir.

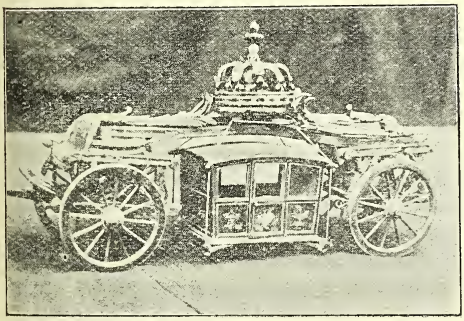
Although these particular coaches appear open, it is certain that when in use they were hung with curtains, and indeed some at still earlier date were provided with sliding panels, for although the coach made for the Earl of Rutland in 1555, and even the more elaborate one constructed for Queen Elizabeth in 1564, by Walter Rippon, do not appear to have had these improvements, they certainly came into vogue later in the same reign. Indeed, in various ways, the revival of carriages would seem to have its chief inception at the end of the 16th and the beginning of the 17th century, although they received a great amount of opposition as we know from the Thames watermen and various Sedan-chair owners, who had, in this country, at least, up till then, enjoyed almost a monopoly in the matter of conveyance, apropos of which controversy there is extant a curious tract entitled "A dialogue between a coach and a Sedan-chair," dated 1636, in which the various merits of both sides are put forth with that redundant exposition so frequent in 17th century literature. The tract is, however, beyond this, interesting, inasmuch as it is adorned by an illustration of a coach of the period, which, as you will see, shows still further signs of development; little beyond glass and springs appear here wanting to bring it very much up to our modern conception of a carriage, and indeed it was not long after this period that glass was introduced into the framework of the body of carriages, although I doubt whether this occurred previous to 1650, although there is a legend extant that an Infanta of Spain used one with this addition in 1631.

Fig. 9.



A Coach of Charles I.

Fig. 10.

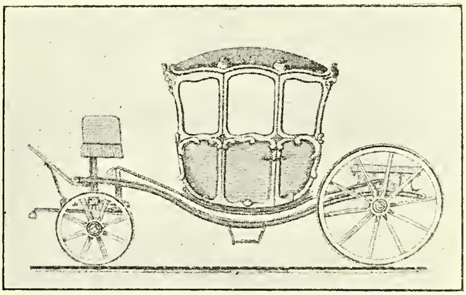


A Dress Carriage of Louis XIV.

On the Continent it was, during the long reign of Louis XIV., that the greatest progress was made in carriage-building, and his Majesty must, himself, have been surprised at the difference in the conveyance which he used when he entered Paris in 1654, from that which he rode in in 1700. M. Roubo, a French author, has left us a more or less technical description of the various improvements introduced into the building of carriages during Louis's long reign, but I think I need not trouble you with it here, as you will see for yourselves the most obvious of these differences in the two illustrations which I am able to present to your notice. I can also show you here a picture of a curious experiment in coach-building of this period, but I do not think this carriage was ever used, as this view is taken from a model now in the Cluny Museum at Paris.

Even the old straps were doomed, and steel springs were introduced so early as 1670, when they were placed between the body of the vehicle. About this time, too, in this country, it is obvious that an impetus was given to this form of industry, for it was in 1677 that the Coachmakers' Company was founded by Charles II., the Charter of the Company being confirmed by James II. Here you will see a representation of the sort of carriage in vogue in the reign of Charles and his brother. As has been observed by Mr. Thrupp, it exactly resembles in shape the coaches on the arms of the Coachmakers' Company.

Fig. 11.



The Berlin.

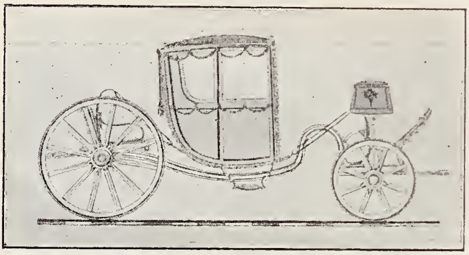
This second illustration will show you what they were using on the Continent at the same period. This is what was known as a Berlin, and was invented in 1660 by Philip de Chiesa, a Piedmontese in the service of Frederick William, of Prussia. It of course took its name from the city where it was first conceived, just as did the Landau and the Coburg.

As the mechanism of carriages was perfected, men began to bestow also much attention on the bodies of the vehicles, and indeed, the elaboration of finish which marked many of them, was only consonant with the love of luxury and ostentation, for which the latter part of the 17th century was remarkable.

Readers of Pepys's Diary will remember the genial author's excitement at the prospect of owning a coach, his interest in the progress of its construction, and his sober satisfaction when, on December 2nd, 1668, he notes that it was "the first time that I ever rode in my own coach."

We must not, however, linger with the diarist, pleasant as his company always is, but must proceed with our slight review of such further improvements in carriage manufacture as the landau, probably the first carriage provided with a moveable framework, which could be put either up or down at will; or the so-called chariot à l'Anglaise, described by M. Roubo in his great book, which had indeed but lately come into fashion, and is not unlike one of those earlier conveyances hung on straps and set upon wheels. Roubo with, we may suppose, a certain amount of jealousy, could see no beauty in this carriage, but is constrained to admit, that the very fact of their coming from England will ensure their popularity.

Fig. 12.



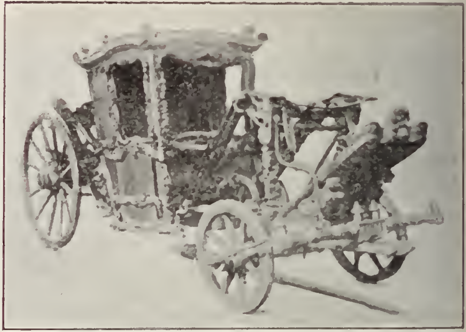
The Chariot a l'Anglaise.

Any of you who may be curious to know all there is to be learned about the progress in the development of carriages during the 18th century, should turn to the great Encyclopœdia, which Diderot and his able coadjutors inaugurated in 1770; there can be gleaned every detail connected with the building and elaborating of carriages, and with Roubo's work as a supplement, the enquirer will, I think, find food for much serious study and reflection.

Such cognate conveyances as post-chaises and cabriolets came into vogue during the end of the 17th century, the latter being introduced into Florence in 1672, and that these little chariots were held in great esteem is shown by the frequent mention of them in the letters and memoirs of the period, particularly in Swift's Journal and Lady Hervey's Letters. They may be almost regarded as the precursors of the modern "pill-box," being small and light, and built to hold only two persons, the "sulky" of America being an analogous vehicle.

About 1740 the use of carriages, even in the colonies, appears to have become more or less general, but to enter into their progress in those parts is here unnecessary. Before, however, passing to the last stage of development in the art of coachbuilding, I may mention that in the Victoria and Albert Museum there was formerly a remarkable coach belonging to the Earl of Darnley, which is said to have been constructed in 1750. You will see by the illustration I am able to give of it, the salient points in its formation. It is not only interesting in itself, but it forms a model of the carriage of the period and helps us to realise, not only how greatly advanced in these matters they were even in the middle of the 18th century, but also what strides we have since made.

Fig. 13.



Lord Darnley's Carriage.

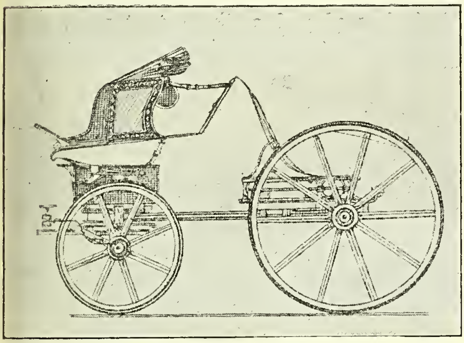
Mr. George Athelstane Thrupp, in his interesting work on carriages, and in the lecture which he delivered in these rooms some twenty-five years since, quotes a coachbuilder, a Mr. Felton, as stating in the year 1690, that "the art of coachbuilding had been in a gradual state of improvement for half a century past," and that "the superior excellence of English workmanship has not only been the occasion of a very great increase in this country, but the exportation of them has become a profitable branch of British commerce," in which flattering remarks our friend of the 17th century joins hands with the great Cicero, whose words I quoted earlier in this paper.

From the year 1770 to 1790 what improvements were made in carriages were largely due to Mr. John Hatchett, of Long-acre, whose taste and acumen was recognised by other members of his craft, who regarded him somewhat in the light of a pioneer.

I am able to show you on the screen a representation of a "Sociable" built by Hatchett, as well as a landau of about the same date, and a landau of 1730. A still more remarkable carriage was the so-called "perch-high phaeton," as you will observe by the illustration. George IV., when Prince of Wales, used to drive in the park in a similar conveyance, and it was regularly used by the young bloods of the period.

Another quaint two-wheeled conveyance of the time was called a "Whisky," while the "Briska," on C springs, and post-chaise of 1790 were used more for travelling purposes—the one I show on the screen is of later date, but in most respects similar to its prototype—and we know how they used to be bodily shipped on to the Packet running between Dover and Calais, their owners sometimes retaining their seats within them, a practice mentioned by Thackeray and other writers of the early Victorian era.

Fig. 14.

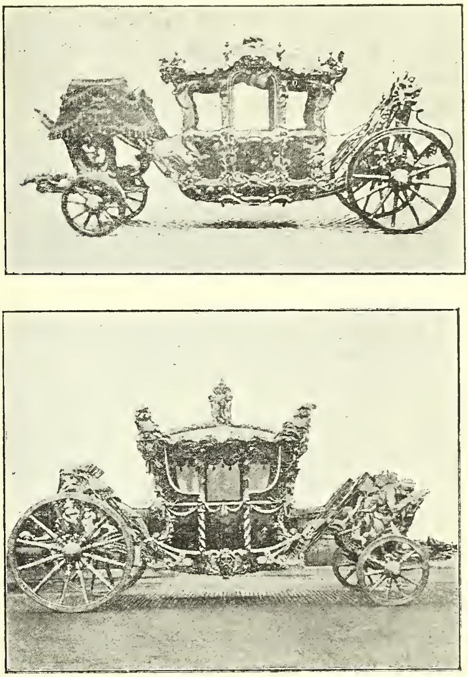


High Perch Phaeton.

The year 1804 is notable in the annals of coachbuilding, for it was in that year that Obadiah Elliott, a coachbuilder of Lambeth, patented his invention of elliptical springs. This was an epoch-making innovation, and the Society of Arts, in whose rooms I am privileged to now address you, recognised the fact by bestowing upon the inventor the gold medal of the Society; indeed, I may mention that the Society of Arts has come forward on more than one occasion to reward ingenious contrivances and to foster their improvement, among the recipients of its generosity in this respect being Mr. T. Hunt and Mr. W. Bailey, as well as Mr. Cuthbert Clarke, all of whom have instituted some lasting improvement in the art of carriage construction.

I need not here recapitulate the names of the most eminent coachbuilders, nor of the works of art which have been from time to time produced under their auspices, down to the present day, when each type of vehicle would seem to be graced by every art, and made perfect by every improvement possible to human conception and ingenuity: but before closing this paper I should like to say a word or two about some more or less famous carriages, and in order to commence suitably I will first refer to that remarkable effort of coachmaking art, which will soon bear His Majesty the King to his coronation. I refer, of course, to the State coach. This remarkable product of coachmaking skill was built in 1762 by Mr. Butler, of Great Queen-street, for the use of George III. at his coronation. The elaborate carvings were by Wilton, the great wood carver, and the paintings in the panels by Cipriani, the whole thing having been designed by Sir William Chambers, and carried out under his directions. A detailed description of it is here unnecessary, for you can see what it is like from the picture of it I am able to show you; but some of the items in the cost of

Fig. 15 (*a* and *b*).



The State Coach of the King.

work may be of some value and interest. The original estimate wns £7,661 odd, but this was finally revised to £6,491. Of this sum the coachbuilder received £1,763; the carver, £2,500; the gilder, £933; the lace-maker, £737; the mercer, £202: the painter (not, I take it, Cipriani, whose magnificent panels must have been paid for separately), £315, and so on.

The coach has been greatly improved lately by the removal of the enormous hammer-cloth (which is said to have swallowed up about £1,000 of the original cost) and the better adjustment of the body of the carriage, so that no jolting is now felt as it was previously; a drawback which is said to have accounted for her late Majesty's dislike to its use. I know indeed for a fact that His Majesty the King, after using it for the opening of Parliament, declared that he had never ridden in an easier carriage.

Her late Majesty used, in consequence of her dislike to the State coach, a smaller and less elaborate one, as you will see by the representation of it, while the landau used by the late Queen in the 1897 jubilee procession is a hardly less gorgeous piece of work.

I am able to shew you here some representations of the State coaches used by various sovereigns on the continent, and amongst them one of those marvellous creations in which Louis of Bavaria loved to traverse his dominions and spread wonders into the minds of his people.

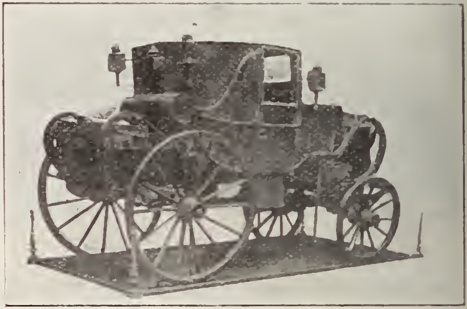
Another remarkable carriage was that used by Napoleon Bonaparte during his many campaigns. In a book entitled "The Horse and Carriage Oracle," edited by the well-known Dr. Kitchener, there is an exhaustive account of it, and the wonderful assortment of objects which it contained. It formed indeed a bedroom or sitting-room at will, and held every conceivable necessary, from a shaving apparatus to a small, but well-stocked library. It was captured after the Battle of Waterloo, and was brought to this country after the 1815 campaign.

At Vienna may still be seen three other carriages once the property of the great conqueror; they were built in 1810, on the occasion of Napoleon's second marriage to Marie Louise of Austria, while a very curious carriage was built by Duke Augustus of Saxe Gotha, and was intended for the use of Napoleon when he entered Gotha in 1808, but probably owing to its fantastic proportions, the emperor refused to ride in it.

Another remarkable product of the coachmakers' art, was the carriage constructed in 1629 for Duke Edward Farnese, on the occasion of his marriage with Margaret of Tuscany. The entire woodwork of this ambitious creation was covered with silver plates, chased and embossed in the most elaborate manner, while the interior was upholstered in crimson velvet and gold thread. It is said that 25,000 ounces of silver were used in its construction, which took twenty-five silversmiths two years to complete.

It is fitting, perhaps, that I should conclude this short notice of particular carriages with a word on the City state coach. This carriage was built in 1757, but, curiously enough, the name of its maker has not come down to us. It is in the Louis Quatorze shape, and is, as you can see for yourselves, a highly elaborate object. Its chief interest would, however, seem to be the number of remarkable scenes in which it has played an important part, and the many notable people who have ridden in it. At the same time I can show you pictures of the Lord Mayor's dress carriage, the State coach of the Speaker of the House of Commons, and of the Lord Chancellor of Ireland.

FIG. 16.

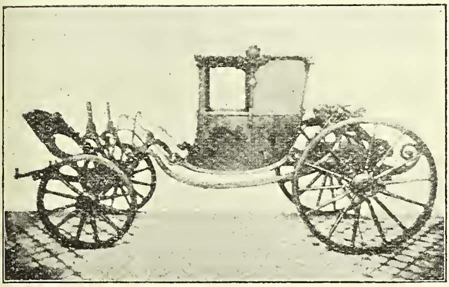


NAPOLEON'S TRAVELLING CARRIAGE.

Before taking leave of my subject, there are one or two more interesting carriages which I should like to illustrate, and which I think will not be without interest for you. Taking them chronologically, the first is the state chariot of George III. This was used on such occasions as did not warrant the use of the State coach; as you will see, it bears some resemblance to a Sedan chair placed on wheels, with the necessary springs and straps. The next illustration is one of the highest interest, for it represents the first carriage used by our late Queen, when she was but a child.

The next picture shows the first brougham ever constructed. It was built in 1838, for Lord Brougham, from whom, of course, it takes its name, and this that follows forms a companion picture to the travelling chariot of the great Napoleon, for it represents the carriage used during manœuvres by His Majesty the German Emperor. It is fitted with a writing slab and other necessary conveniences.

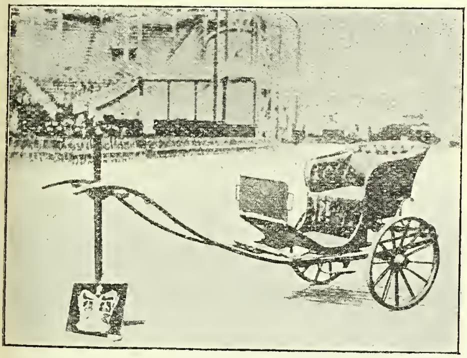
Fig. 17.



George III.'s State Chariot.

The following illustrations are so cognate to our subject that I think no excuse is necessary for presenting them to you. The first is one of the earliest cabs, called Boulnois' cab, on account of its having been invented and patented by Mr. William Boulnois, the father of my friend, Mr. Edmund Boulnois, M.P. It was a two-wheeled closed vehicle constructed to carry two passengers, sitting opposite each other, and I am indebted for the illustration to Mr. H. E. Moore, the author of "Omnibuses and Cabs," a most interesting and instructive work. The next is Shillibeer's first omnibus, built by Mr. George Shillibeer, a well-known Parisian coachbuilder of the period, which began to run in London on July 4th, 1829.

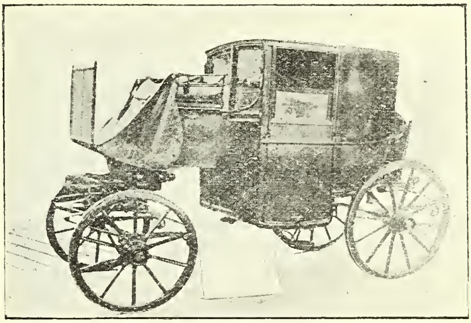
Fig. 18.



The Late Queen Victoria's First Carriage.

The Richmond omnibus, which is now shewn you, commenced to run some years later, and I possess some of the company's time-tables and fare-cards, by which I see that the charge from Richmond to London was 1s., and an omnibus leaving Richmond at 12.35 was due at the Bank at 2.28. From that time to the present day when the London Road Car Company's motor omnibuses have commenced to run, as they did for the first time in March last, is a long cry — almost as long as these two former modes of conveyance, an early Bavarian sledge and a modern one belonging to the German Emperor, to this, my last illustration, which, by the gracious permission of His Majesty the King, I am able to present to you. A motor car fitted with every up to date appliance, in which His Majesty frequently drives, and thereby shows that he is ever ready to encourage progress in all its most interesting and useful forms, and the new State landau to be used in the Coronation procession in June, which latter fittingly completes, I think, my series of illustrations.

Fig. 19.

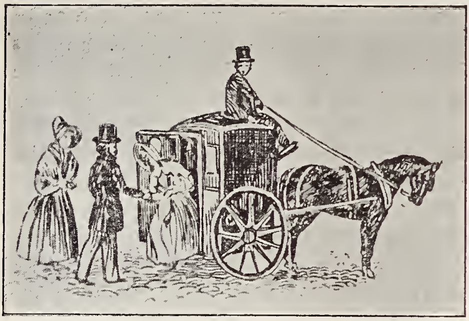


The First Brougham.

It is a matter of some regret that time forbids me to enlarge on a subject that is fraught with so many interesting reminiscences as is this of the rise and development of coachbuilding in England and abroad.

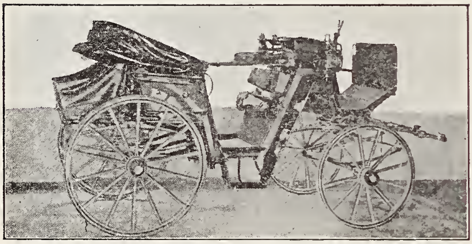
I have tried to trace, in a necessarily cursory way its inception in the misty ages of antiquity, its development in later times, and its apotheosis in our own day when, if we cannot boast of the highly elaborate conveyances of the 18th century, it is because our manner of life has taken on it a more sober hue than was the case with our forefathers. We have, however, outstripped them in those chief essentials of comfort and utility which makes

FIG. 20.



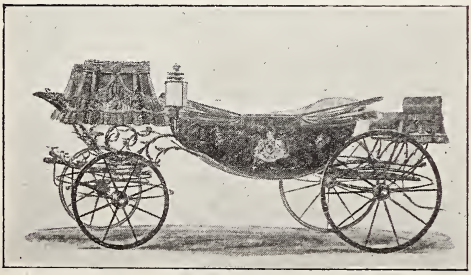
BOULNOIS' CAB.

FIG. 21.



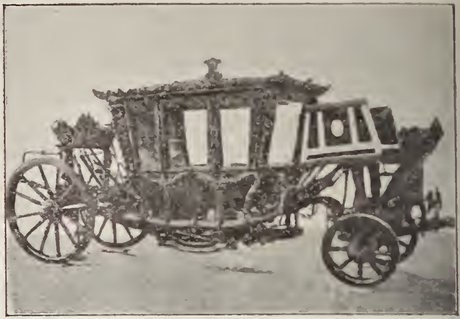
THE GERMAN EMPEROR'S CARRIAGE FOR MANŒUVRES.

FIG. 22.



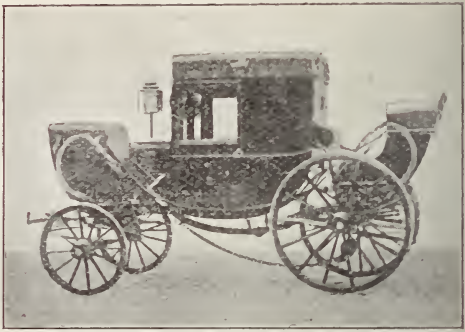
THE LATE QUEEN VICTORIA'S JUBILEE LANDAU.

FIG. 23.



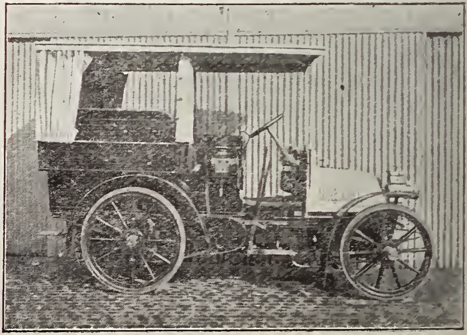
THE COACH OF THE SPEAKER OF THE HOUSE OF COMMONS.

FIG. 24.



A TRAVELLING CARRIAGE OF 1840-1850.

FIG. 25.



THE KING'S MOTOR CAR.

the carriage exercise of to-day the most luxurious of all forms of conveyance. It is for this reason that many of those wonderful objects which were in vogue in the early part of the 19th century, and which we see represented in the prints and pictures of the period have fallen into disuse—they were curious and thus noticeable, but they were not always beautiful nor did they conduce to comfort, and so we will have none of them.

Perhaps in some future ages the motor car and the air-ship will hold the monopoly of conveyance, but when such a time arrives, if it ever does, I doubt if life will be more beautiful, or if existence will be worth more than it is to-day, when the brougham and the victoria, the landau, and the barouche, are still with us, and the oil of the motor is but infrequently smelt in the land.

It has given me peculiar pleasure to be privileged to address to you these few words so unworthy of the large subject I have attempted to handle, but if anything could enable me to forget any shortcomings in the way I have dealt with it, it would be the patience with which you have listened to my words, and the reception you have so generously accorded to me.

DISCUSSION.

Mr. George N. Hooper said Mr. Chancellor had performed a feat that evening which had not before been performed by a Master of a City Company. Although not a coachmaker himself, he had, at infinite trouble, brought together facts which had enabled him to read a paper which was not only most creditable to himself and highly instructive to his audience, but which would encourage masters of other companies to contribute to our knowledge in the same way. The name of Chancellor had been well known for generations in connection with the Coachmakers' Company, and the author of the present paper was the third of that name whom he had known as holding the office of master. Though not directly connected with the manufacture of private carriages, Mr. Albert Chancellor's ancestors had had a great deal to do, during the past centuries, with the mail and stage coaches. Travelling by such vehicles, about the period that railways came into vogue, had attained a perfection which had never been reached in any other country, and Mr. Chancellor's ancestors had greatly contributed to the success of the locomotion of their time. Locomotion, too, had been greatly facilitated by the attention which was drawn to the roads of the country. It was England that a century ago awoke to the fact that improvement of the lines of communication was the way to civilise a country, and promote the good of its inhabitants. As soon as ever the roads were made sufficiently good to carry better carriages, better carriages were constructed. He, however, differed from Mr. Chancellor in one respect. Mr. Chancellor had awarded credit to German coachmakers for having given perfection to the underworks of carriages. He, on the other hand, was always of opinion that in the underwork the Germans were weak, because it was really the want of proportion which led to failure. Some fifty or sixty years ago, when the young noblemen of England were sent to travel over Europe, the carriages, which were sent out from London with them, constantly returned without injury or accident; while the same could not be said of foreign carriages. The good materials put into the London carriages gave them such a reputation, that the Sovereigns of Europe were attracted over here, and they gave orders to London makers rather than to those in their own countries. In the present days of Parliamentary government, and civil and religious liberty, this country enjoyed advantages which were not enjoyed by our ancestors. For instance, not long after the charter was granted by Charles II. to the Coachmakers' Company, another king (James II.) withdrew it; and it was only after a considerable agitation that the charter was returned to them. One of the pioneers in the collection of facts relating to the history of carriages, viz., Mr. Thrupp, was unfortunately absent this evening. Reference was made by Mr. Chancellor to Mr. Shillibeer. Now, Mr. Shillibeer was an Englishman, and a landowner. True he went over to Paris, and the only reason that he (Mr. Hooper) could think of as the cause was that sometimes a prophet was not honoured in his own country. Mr. Shillibeer invented the omnibus, and first set it rolling in Paris, and it would be interesting to know what induced him to begin on the other side of the channel. However, Londoners who had been to Paris in the days referred to, very soon appreciated the advantage of a vehicle which would carry a large number of persons at a minimum rate, so the vehicle was soon brought to the metropolis. A few days ago the Lord Mayor delivered a most interesting address to the students who had gained prizes at the City and Guilds of London Institute. In that address the Lord Mayor seemed to claim for that Institute the introduction of technical examinations as carried on by the Institute. On the contrary, it really was brought about by the Society of Arts, and a former chairman of the Council, Sir John Donnelly, was the one who was the means of bringing it about. Sir John consulted him (Mr. Hooper) and others 30 years ago as to whether it was not possible to establish technical examinations. He (Mr. Hooper) was one of the first five examiners. After the examinations had been going on in the Society of Arts for five or six years, and the funds of the City Guilds were available for a much more extensive scheme, they were handed over to the Institute. He thought the Society of Arts should have the credit for having inaugurated the system which now embraced the examination of over 5,000 students each year, and was the cause of placing the country in a far better position than before Sir John Donnelly took up the idea which he did.

Mr. CHARLES HOLMES (Derby) said he had travelled up specially from Birmingham that evening to hear his worthy friend and master, Mr. Chancellor, and speaking for himself and his brother coachmakers present, he could not but say that the paper and the lantern slides had given them all much pleasure and instruction.

Mr. THORNE said the whole subject had been most ably handled, and Mr. Chancellor had placed the subject before his audience with much ability.

Mr. GEORGE OFFORD said he would like to carry the history of coachbuilding much further back than Mr. Chancellor had done. For instance, on a very ancient Babylonian tablet they found what was called the long chariot, which was a four wheeled vehicle. Others had been recently published, which showed carriages with four wheels, while there were two Hittite tablets showing the same number, and also some Egyptian pictures. The "chariot" mentioned in the Song of Solomon, to his mind was not really a chariot, but a litter. That was particularly interesting, because the word was one found only on the Cappadocian tablets. With regard to the development of wheels, the earliest representation we had of wheels, with spokes, showed four only. In the Theban chariot it was discovered that there were six spokes, while again, in the Egyptian chariots there were eight spokes. Then, again, there was a bas relief where a vehicle was shown with six, and as many as twelve spokes in each wheel. The spokes were put "in and out," which position some people contended gave strength to the wheel. Then there were the Greek cars. The earliest of the Greek carriages had four spokes, and he thought he was not wrong in coming to the conclusion that the Greeks copied their chariot wheels from the Egyptians. The first time that he found six and eight spokes represented was in Cyprus, where were some figures on a sarcophagus which represented the former numbers, while later on others were discovered with eight. Afterwards the Lydian chariots were discovered, and they were found to have as many as eight spokes.

Mr. R. K. GRAY said Mr. Chancellor had referred to the elliptical springs, which ensured easy travelling, but he had hoped to have heard something about the tyres which were now used, making the vehicles noiseless, and so comfortable that people could not only ride comfortably, but were able to talk with freedom. He would have been glad if some reference had been made to that part of the matter, as the paper read that evening was likely to become historical.

The CHAIRMAN, in moving a vote of thanks to the reader of the paper, said that Mr. Chancellor had favoured them with a learned, admirably illustrated, and altogether most instructive and interesting review of the evolution of the carriage. It was impossible to include everything in such a review, and Mr. Chancellor had from the first kept steadily in mind the history of the development of the carriage in Europe. All the same he would have liked to have found among the lantern slides a few representations of the indigenous carriages of India. When he left Bombay 33 years ago, although spoked wheels were to be seen almost everywhere, and particularly in the neighbourhood of the Presidency towns, and the larger British naval and military stations, solid wheels, either of planked wood, or shaped out of a transverse section of the stout trunk of some tree, were still in use; and he had occasionally seen, in remotely sequestered rural tracts, carts drawn on stone wheels, hewn solid from the basalt rock, which is the prevailing geological formation of Western India. One very interesting point was that the old towered temples of the Hindus would seem to have been modelled after the primitive carriage in which the idols worshipped by them were carried about, and are still carried in the periodical processions of their gods. India, beyond the Presidency towns, and the administrative and railway and telegraph stations, still remained a living survival of antiquity, and it was always useful to have India in view when examining any such matters as the present. The etymology of coach was habitually traced to a town called Coaxa, in Hungary; and again it was said that the town so called derived its name from coach. He found, however, that Sayce derives the term, through the French *coche* [a doublet of *coque*, "shell"] from the Greek κόγχη, "a cockle," cognate with the Sanskrit, *Cankha*. He had been greatly comforted by the conciliatory terms in which Mr. Chancellor had spoken of the motor car. He regarded it as an abomination of desolation, destructive at once of the amenity of our streets, and the serenity of the country side. But when a gentleman who so sympathetically appreciated the artistic as well as the utilitarian side of coachbuilding as Mr. Chancellor did, could speak favourably of the motor car, he felt hopeful of the artistic assimilation of that wonderful invention being now not far remote. He had been equally prejudiced against the bicycle, and what had reconciled him to it at last, was not the improvements in its lines of construction which were still wanting in grace, but one day reading in Cowper's "Task" the lines:—

> "By ceaseless action all that is subsists.
> Constant rotation of *the unwearied wheel*
> *That Nature rides upon*, maintains her health,
> Her beauty, her fertility. She dreads
> An instant's pause; and lives but while she moves.
> Its own revolvency upholds the World."

Since then every young man I see on a bicycle is Triptolemus, and every woman Venus Victrix! The motor-car, until someone is able to construct it as "a thing of beauty," is in direful need of some such glamour of association;—which has been cast over the intrusive and hideous *char-à-banc* in Devonshire by the country people designating it "Cherubim."

Mr. CHANCELLOR, in replying to the discussion, said that with reference to tyres, he felt that if he had trespassed upon that ground, he should have had to read a paper entirely on tyres, because there were tyres of every description for almost every kind of vehicle. For instance, there were six inch, as well as three inch and one inch tyres. Therefore he did not dare touch upon the subject without going through the past, and giving credit for what the Romans, Egyptians, Assyrians, and others used in their day. The subject he had undertaken was a very wide one, and he ventured to think that if something were to be said with regard to India, it would be most interesting. But he thought he would leave that for another time, so that India and the Colonies might form a subject of themselves. He had simply dealt with illustrations of carriages from ancient times up to the present day. He could only add that it had afforded him a great deal of pleasure to have taken the trouble he had in presenting his paper to the Society, and he was much gratified by the vote of thanks and the Chairman's kind expressions of appreciation.

Miscellaneous.

THE INDUSTRIES OF TUNIS.

Tunis was formerly one of the greatest industrial centres of Mohammedan Africa, its products were distributed throughout the northern part of the continent, and caravans carried them into the heart of the Soudan. This period of activity and the prosperity of which it was the source have disappeared under the influence of various causes, the chief of which is the competition of European manufacturers, who, with the aid of improved machinery, are able to copy more or less accurately certain local products and to send them to Mohammedan countries. For example, the *chéchias* (red caps) are now for the most part of Austrian origin; the Tunisian manufacturers, slaves to their traditional processes, continue to make them of a better quality, but dearer, and so see their trade vanish. There are, however, according to the *Quinzaine Coloniale*, certain textile products which have not disappeared. Silk-weaving and dyeing support some 4,000 people at Tunis, and wool-weaving occupies a certain additional number throughout the regency. They manufacture the different articles of native wear, as the burnoos, which everyone knows; the large blouses called, according to their style or fineness, *gebba* or *gandoura*, the coverings in which men and women wrap themselves; the cloak with a hood; the *haik*, a silk covering worn by women out of doors; the face covering also worn by native women; besides the blankets and rugs, which are the most important pieces of Mussulman furniture. Indeed, the fame of the rugs of Kairwan equals that of the finest of the Orient. The great variety of these native articles and their multiple dimensions necessitate a special manufacture, incompatible with the wholesale production of machinery.

MINERAL RESOURCES OF YUNNAN.

It has long been known that the Chinese Empire contained numerous deposits of coal, but only very recently has Yunnan been counted among the districts provided with coal resources. The district comprised approximately between the Red River of the south, the meridian of Haïphong on the east, and the Blue River, is destined to become one of the most interesting mineral countries of the globe. It has an almost uniform geological conformation, and most of the beds have been worked by the Chinese. Its chief mineral wealth besides coal consists of copper and tin. Extensive deposits of mercury have also been found. The mines of Hong-Hai contain coal beds of very remarkable thickness and regularity, and the product is relatively pure so far as ashes are concerned; but, unfortunately, this fuel is very brittle, takes a long time to light, and crackles under fire; it gives an excessive proportion of fine coal, which can only be changed into briquettes by mixing it with Japanese coal. The copper mines of Yunnan have been worked for more than a thousand years. In the mining regions the forests have entirely disappeared, wood charcoal being the only fuel employed for the needs of ancient metallurgy. According to the *Bulletin de Geographie Commerciale*, the production in the 12th century reached 6,000 tons of copper; the output is now limited to about 1,500 tons on account of the scarcity of fuel. The ore from the accessible parts of the beds is exhausted by the Chinese miners. The deep veins remain, and can only be worked by modern methods. These are so exceptional on account of their extent, that the country may become one of the most important centres of the manufacture of copper. The tin mines of the region of Mong-Tzé, are actively worked by a mining population of about 30,000 people. These beds are of peculiar character, with accumulations of red clay, filled with grains of oxide of tin, which the Chinese, with their cheap manual labour, easily separate by washing. The tin, manufactured by wood charcoal, is much less pure than that of Malaysia. The total production is some 1,500 tons. About 1,000 tons are sent to Hong Kong to be refined. All the beds have been known for a long time, and remain legally at the disposition of the mining population. A new legal organisation is necessary in order to render the mines of China accessible to mining industry, without infringing on the rights of the people. The present management of the mines is based on the system of privileges and of monopoly, which is the foundation of all mandarin administration.

Obituary.

Horace George Bowen.—Mr. Bowen, lately Chief Cashier of the Bank of England, died on 6th inst., at Barton-on-Sea, Hampshire. He was born in 1841, and entered the service of the Bank of England in August, 1860. In 1888 he occupied the post of Deputy Chief Accountant, and owing to the illness of Mr. S. O. Gray, the head of the department, a great deal of laborious and responsible work arising out of Mr. Goschen's conversion of the National Debt fell upon him. On Mr. Gray's retirement, Mr. Bowen became Chief Accountant, and five years later, in November, 1893, he succeeded the late Mr. Frank May, as Chief Cashier, a post which he held until January, 1902, when he was obliged to retire on account of ill health. He had been a member of the Society of Arts since 1897.

Professor Cornu.—Prof. Marie Alfred Cornu, the famous Professor of Physics at the Ecole Polytechnique, Paris, died last month at his residence in Paris. He was born in 1841, at Chateauneuf, and entered the Ecole Polytechnique at the age of nineteen. At the age of twenty-six he was chosen for the professorship, which he held for the remainder of life. He was president of the Académie des Sciences, twice president of the Société des Physique, and in 1900, president of the International Congress of Physics. On more than one occasion he delivered Friday evening discourses at the Royal Institution, and in 1899 he was Rede lecturer at Cambridge, the subject of his lectures being, "The Wave Theory of Light, and its Influence on Modern Physics." In 1878 he received the Rumford medal of the Royal Society for his work on the velocity of light, and in 1884 he was elected a Foreign Member of the Royal Society. He was also elected an Honorary Corresponding Member of the Society of Arts in 1897.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesdays :—

May 14 (4.30 p.m.).—"Boats and Boat Building in the Malay Peninsula." By H. Warington Smyth. Major-General J. B. Stirling will preside.

⁂ The attention of members is directed to the alteration of the hour. This meeting will be held in the afternoon, at 4.30 p.m., instead of in the evening at 8 p.m.

COLONIAL SECTION.

Thursday afternoon, 4.30 o'clock :—

May 29.—"Western Australia : its Progress and Resources." By the Hon. H. W. Venn.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 12...Electrical Engineers (at the House of the Society of Arts), John-street, Adelphi, W.C., 8 p.m. Conference.

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8 p.m. General Meeting.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. T. Chaplin, "Diseases Recorded in the Bible."

Tuesday, May 13...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. York Powell, "English Kings and Kingship." (Lecture III.)

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. Fritz Mollmorgen, "A New Apochromatic Form of Zeiss Planar Lens."

Asiatic, 22, Albemarle-street, W. 3 p.m. Annual Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Canon Dalton, "The Recent Royal Tour."

United Service Institution, Whitehall, S.W., 3 p.m. Prof. George Forbes, "Experiences in South Africa with the New Infantry Range-Finder."

Wednesday, May 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. H. Warington Smyth, "Boats and Boat Building in the Malay Peninsula."

Royal Society, Burlington-house, W., 9 p.m. Soirée.

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, S.W., 8½ p.m. "Notes and Queries" Meeting.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Thursday, May 18...Electrical Engineers (at the House of the Society of Arts), John-street, Adelphi, W.C., 8 p.m. Professor C. A. Carus-Wilson, "Electrical Traction on Steam Railways in Italy."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Captain Horace Hayes, "Suggested Improvements in Military Horse Management."

Society for the Encouragement of Fine Arts, 9 p.m. Mr. Philip H. Newman, "Pageantry and Art."

Royal Institution, Albemarle-street, W., 8 p.m., Dr. A. Smith Woodward, "Recent Geological Discoveries." (Lecture III.)

Historical, Clifford's-inn, Fleet-street, E.C., 5 p.m.

Optical, Northampton Institute, St. John-street-road, E.C., 8 p.m., Dr. C. V. Drysdale, "The Testing of Optical Instruments."

Numismatic, 22, Albemarle-street, W., 7 p.m.

Friday, May 16...United Service Institute, Whitehall-yard, 3 p.m. Captain G. W. Redway, "Complexity in Army Accounts."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Sir Robert Ball, "The Nebular Theory."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, May 17...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Walter Rayleigh, "Poets and Poetry." (Lecture III.)

Journal of the Society of Arts,

No. 2,582. Vol. L.

FRIDAY, MAY 16, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

As His Majesty's Coronation is to take place on Thursday, the 26th of June, the Council, acting under the provisions of Byelaw No. XLIV., have resolved to postpone the date of the Annual General Meeting from Wednesday, June 25th, to Wednesday, July 9th.

The regular notice required by the Bye-laws will be issued in due course.

Henry Trueman Wood,
Secretary.

CONVERSAZIONE.

The Society's Conversazione will take place at the Royal Botanic Gardens, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 p.m.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards will be forwarded in due course. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 14, 1902; Major-General John Barton Sterling in the chair.

The following candidates were proposed for election as members of the Society:—

Birch, John de Gray, J.P., Umtali, Rhodesia, South Africa.
Darroll, George, 16, Hout-street, Cape Town, South Africa.
Halsted, Professor George Bruce, The Neomon, 2407, Guadalupe-street, Austin, Texas, U.S., America.
Pearson, Sam Garforth, Axim, Gold Coast Colony, West Africa.
Richardson, Stuart, M.I.E.E., 117, Brougham-street, Wellington, New Zealand.
Talley, Thomas W., M.A., D.Sc., Tuskegee, Alabama, U.S., America.
Woodburn, J. Allan, care of Rezende, Limited, Suffolk-house, Cannon-street, E.C., and Umtali, Rhodesia, South Africa.

The following candidates were balloted for, and duly elected members of the Society:—

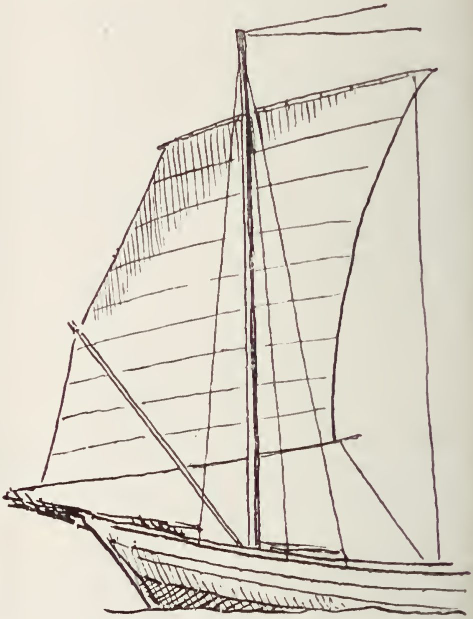
Fleming, C. A., Executive Engineer, Punjab Irrigation Department, Shahpur, Punjab, India.
Lawson, Sir Charles Allen, 15, Evelyn-gardens, S.W.
Munster, B. A., No. 23, Yokohama, Japan.
Porter, H. G. 22 and 23, Princes-street, Hanover-square, W.
Baldrey, Robert John, Ootacamund, Nilgiris, India.
Brooks, Joseph, F.R.A.S., F.R.G.S., Hope Bank, Nelson-street, Woollahra, *via* Sydney, New South Wales, Australia.
Burnham, Daniel Hudson, The Rookery, Chicago, U.S., America.

The paper read was—

BOATS AND BOAT BUILDING IN THE MALAY PENINSULA.

By H. Warington Smyth.*

Having regard to the wide reputation which the Malays have earned for themselves as a maritime people in Eastern seas, it is at first sight not a little remarkable that so far as the Malay Peninsula is concerned, they have developed no really able type of sea-going boat.† European writers have credited the Malays with building boats, the lines of which are unsurpassed by European types; yet so far as the writer has been able to discover, no specimen answering to such a description is to be met with in the Peninsula. The characteristics of build are small displacement, hollow lines, V-shaped sections and sharp floors, shallow draft, lack of beam, and a consequent want of stability and weatherliness. An enquiry into local conditions, however, explains much. Two main factors have been at work, influencing the development of boats, and tending to produce the results arrived at. In the first place, the rivers, which almost invariably constitute the ports of the Peninsula, are, with scarcely one exception, protected by very shallow bars of sand or mud, which make it impossible for a deep-bodied boat to obtain shelter within them. These bars are caused by the vast quantities of detritus brought down by the rivers in flood time, as a result of the very heavy tropical rainfall;‡ detrital fans of mud are deposited around their mouths, over which the mangroves steadily grope their way out to sea; the current keeps open a channel, which is of fair depth within, but shallow and shifting upon the bar, varying often with the strength and direction of the wind prevailing outside.* Safely ensconced within these creeks, protected from observation by the mangroves, and from pursuit by the shallow bars, the old Malay pirates scarcely 60 years ago used to watch the seaboard traffic of the Straits and swarm out upon their chosen prey. When pursued by the boats of Her Majesty's ships, they would make good their escape by just bumping over a friendly bar, where their pursuers could not follow them, and then turning aside up some of the innumerable creeks that intersect the mangrove swamps near the river mouths. Hence came the necessity for shallow draft and small tonnage.



Fore-mast, with Square Sail.

A second factor, scarcely less potent, so far as the west coast of the Peninsula, from Penang to Singapore, is concerned, has been the variable character of the light breezes prevailing in the Straits of Malacca. The monsoon currents of the neighbouring seas do not blow with any regularity or force, owing to the protection afforded by the island of Sumatra on the south-west, and the Peninsula on the east; and the usual light winds are varied only by occasional south-westerly squalls of great violence but short duration, known as "Sumatras." A third factor was the great strength of the tides, which on the Selangor coast-line have a rise and fall of as much as 20 feet. The lot of the sailing vessel in this neighbourhood is thus precarious; racing tides and baffling winds and calms make progress very slow. Hence propulsion by oars or paddles was the first necessity of the old-time Malay seaman in the Straits; sails were merely an occasional convenience. He soon found that a long light craft, having plenty of accommodation along its sides for paddlers, was by far the best adapted to the navigation of these waters, and, moreover, had the sailing vessel at its mercy nine times out of ten—a very pleasing feature in the eyes of the Malay at the time when the Straits of Malacca served as the high road for all the sailing tonnage of the Eastern trade. Moreover the lack of freeboard suitable for manual propulsion was not a serious danger in a locality where heavy weather is so little known. Hence it came about that the "long canoe" form of craft established itself as the most suitable type, and that not only, as was natural, for the river navigation of the interior, but also for the estuaries, and the more open waters of the Straits. Steam, and the growth of the British power in the Straits have combined to make impossible the old buccaneering pursuits dear to the heart of the Malay sailor, and he is now constrained to ship as a folks'le hand in Penang or Singapore steamers, or make sailing voyages up and down the coasts as a commonplace trader or peaceful fisherman.

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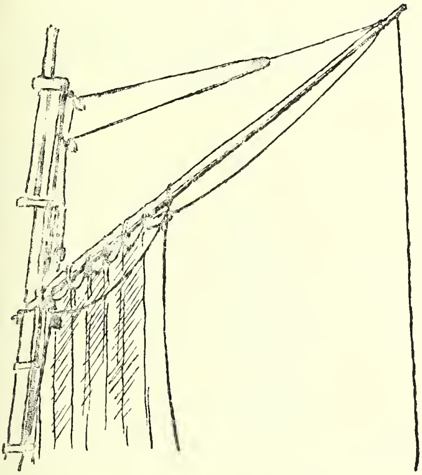
* The paper was written by Mr. H. Warington Smyth (who is now in South Africa), from information supplied by Mr. W. W. Skeat, who presented a large collection of Malay boat models to the Archæological Museum at Cambridge, from which many of the illustrations in the present paper are taken.

† The question of what constitutes a "boat," properly speaking, is not always easy to decide. Many of the Malay craft, up to 70 feet in length, may, owing to their narrow beam and shallow draft, be legitimately styled boats, especially as they are by no means invariably decked in. The line which divides a boat from a sea-going vessel, is, on the whole, very arbitrary, and varies really with the seaworthiness, or sea-keeping power of the type under discussion. For instance, the Penzance lugger of 40 feet long, or the Norwegian pilot "boat," of somewhat similar dimensions, is, from a sea-keeping point of view, not a "boat" at all, while the native canoe, a hundred feet long, as certainly falls within the category for all purposes.

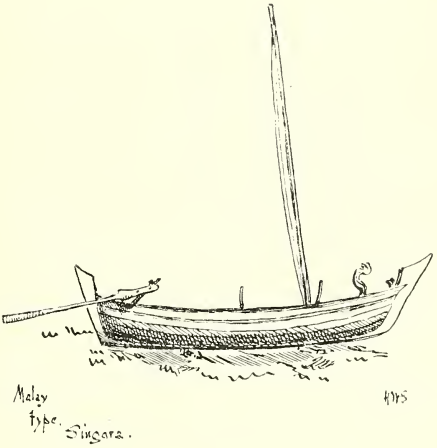
‡ Upwards of 110 inches per annum, in some inland districts.

* In many parts of the Peninsula, the on-shore monsoon causes wholesale alterations in the banks and channels of these bars, and leaves enormous deposits of sand in the river entrances, through which the fresh water has to cut a new channel to the sea, nearly every season.



TOP-MAST AND GAFF.

The foregoing remarks are not, however, entirely applicable to the east coast of the Peninsula, where during the prevalence of the north-east monsoon in the China sea, strong gales with heavy sea and violent rain blow havoc upon the unprotected coast line. At first sight then, we might have expected to find some powerful sea-keeping boats on this coast; but in fact, we find practically the same types as on the sheltered waters of the Malacca Straits. The explanation is easy. During the prevalence of the on-shore monsoon, the bars at the entrance to the rivers, which form the only ports, are a whirling mass of breaking seas, through which, only during rare lulls in the weather, can any vessel pass with safety.[*] From the shelving beaches thrown up by the monsoon it is, of course, impossible to launch a boat. Hence from October or November to February or later, according to the strength of the weather, the whole coast is shut up, so far as local navigation is concerned. An occasional high-sided Chinese junk will now and then venture along the coast, but communication in most cases becomes easier across the Peninsula, and the men of Patani and Singora find it simpler to cross overland to Kedah to reach the west coast, than to attempt to get out across the dangerous bars, and through the heavy sea raging on the eastern coast.



During the open season the weather is not unlike that in the Straits, bringing light sea and land breezes, varied by occasional squalls. Then the Malay fishermen run their long canoes down the beach and put to sea again, and the traders creep out with new mat sails to resume their coasting voyages.

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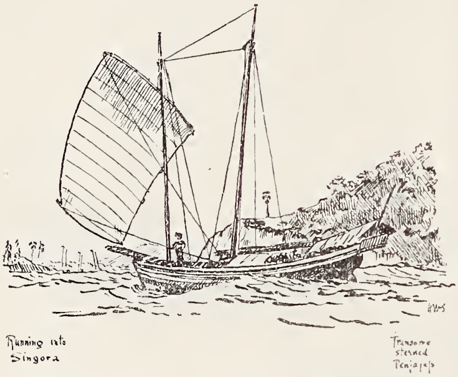
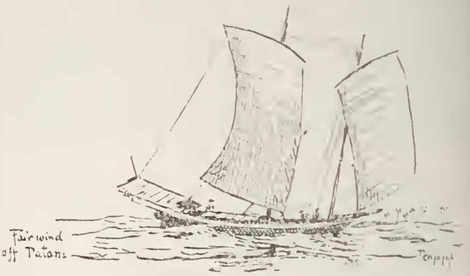
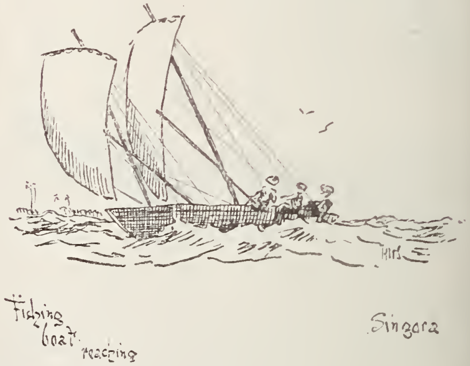
[*] To such an extent is this the case, that the north-east monsoon is called by the Malays, "Musim Tutop Kuala," or the "shut-port [i e. close] season."

Owing to lack of ports free from shallow bars large displacement is impossible; and for the fishermen, light canoe-like craft are preferred, as they launch easily from the beach, and can be paddled at high speeds to come up with fish. Hence deep-bodied boats which can beat to windward are again absent on this coast; and as the centre board and the leeboard is not known, the paddle retains its importance for working to windward. Though hardly coming under the heading of boats it should be remarked that for some trades, involving long voyages and calls at deep water ports, the advantages of big-bodied craft are fully recognised by the Peninsular Malays, and that between Singapore and Siamese ports, for instance, fine vessels of 200 tons, built on European lines, are frequently to be met with. They are rather nondescript craft, often with overhanging clipper stems and deck-houses galore. The masts are generally very light and crooked-grown spars; the rigging and gear aloft make up in quantity what is lacking in quality. They are generally rigged with two nearly equal-sized masts and bowsprit on which from one to three jibs are set. The mainsail and foresail are either Chinese lugs or on the European fore and aft plan, the gaff being a standing spar controlled by vangs, and the sail being set by hauling out along it and taken in by brails to the mast, topsails being used. The sails are of light material, when they are not, as in the case of regular Chinese or Malay lugs, made of matting; and they seldom set very flat.



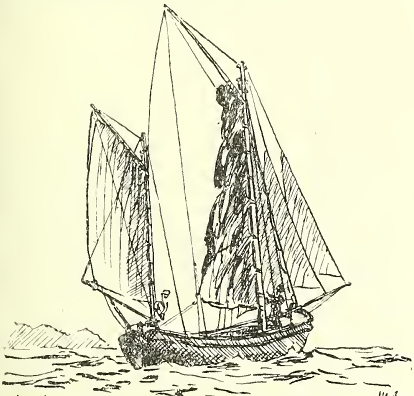
The true Malay sail, however, is nothing more than an adaptation of the original and primitive square sail, as used alike by the sailors of ancient Egypt, of Rome, and of Scandinavia; and this sail is used still in the majority of the Malay fishing craft and small traders, matting being the material used. A boom along the foot is almost as necessary as a yard along the head. The Malays, by the simple expedient of tilting the sail forward, so as to bring the tack right to the deck, have long converted this square-cut sail into the most powerful of lifting sails on a wind. The dipping lug is set taut along the luff by a spar bowline fitting in a cringle, the lower end of which comes to the deck abaft the mast. The yard being too light to stand alone by the wind, is invariably controlled by a vang. The unhandiness of the dipping lug in tacking is felt to the full with this sail, owing to the stiffness and weight given to it by the material of which it is made, and the boom along the foot; and the operation is such a long one, that the anchor is often thrown over while the manœuvre is gone through with the two big sails.





The devotion of the Malays to top hamper in the shape of raised deck houses and outrigged superstructures over the bow and stern, is shared with many other Eastern races, and is no doubt largely owing to the lack of body in their craft. In boats with sharp bottoms and fine lines, the cargo, whether of fish or merchandise, has often to lie high; and consequently all the accommodation for the crew is high up, and every foot of extra space which can be built on in this manner is so much added to their comfort, and to convenience in working the vessel. The galleries built out over the bows of the larger craft are used for working and storing the anchors, just as was the case in the vessels of the classical and mediæval seamen, and as still remains the rule in the Chinese junks; and in boats which are often so lean about the quarters the little stern galleries and rails add greatly to the comfort and safety of the steersman and of men handling the mainsail.

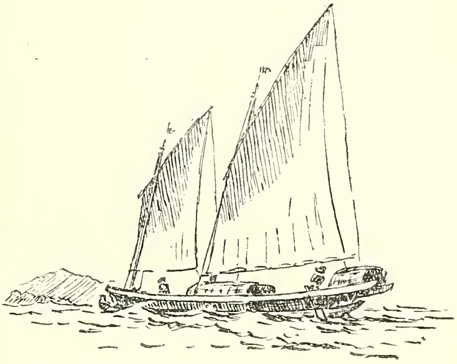
Even in the smallest canoes, which most of us would think crank under any circumstances, there is generally in the East a grating (or lattice) forming a raised floor, within an inch or two of the top of the gunwale, upon which the crew is accommodated. It can certainly not be claimed that such an arrangement conduces to stability; yet such good watermen are these warm water sailors, and the Malays in particular, that even long coasting voyages are undertaken in such craft without any apparent anxiety as to the result.



Singapore
Lighter
trailing mainsail

The *Penjajap* on the east coast is often a rather unsuccessful imitation of European build, with transome stern, half concealed by the overhanging stern galleries. There is generally plenty of show, but the boat is very wall-sided, with insufficient beam, which facts combine to spoil her appearance on a close inspection, although she looks smart enough a little distance off. The writer has seen these boats nearly on their beam ends when caught by a heavy squall at anchor, though with nothing but their slender masts aloft, a fact largely caused by the want of under-water body in the hull, and the amount of top-hamper by way of accommodation on deck. A bundle of bamboos along under each gunwale frequently adds some much needed stability, and provides a store from which to renew broken spars. Yet crank as these craft seem the Malays manage to make their way for long distances in them with very few accidents. No fact could form more conclusive evidence of their pluck and skill.

The Malay, like a true seaman, takes a great pride in his vessel, and if his ideas of ornamental decoration do not always accord with those of the West, he has, at all events, never been guilty of producing such scarecrows of the seas as many of the tramp steamers at this moment lying in the port of London. In rigging, as already hinted, he is partial to slender lofty masts, and if his vessel is large enough he indulges in two masts of nearly equal height, to which is generally given a very smart rake forward. Under Chinese sails, the advantages of which, over the dipping lug, have been recognised by many on the east coast, the Malay may be distinguished from the Chinaman at sea, when yet hull down, by the equal size of the big sails, and the invariable absence of any mizen. The hull is also low and long, with no many-storied castle aft, but merely a *kadjang* or thatch awning, over the raised, overhanging poops, or a simple *dandan* or gallery. There is something of the yachtsman in the Malay, and he is much addicted to graceful little vanities about the stern-head and stern-post of his small boats; and so greatly does he hold the figure-head in estimation, that a class of boat is often named after the form given to the stern-head. European influence may now be seen at work to a

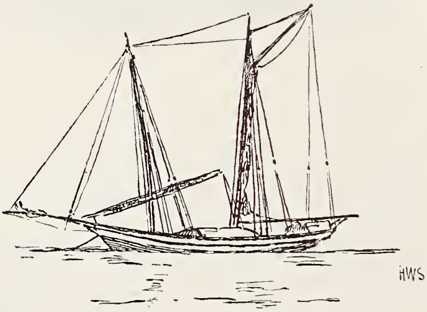


Lake boat,
Singora

greater or less degree in almost every class of rig in the ports of the Peninsula, but the Malay more than any other Oriental, has adopted the jib, or three-corned staysail. This essentially modern product of Western Europe, he has adopted not only in the large traders already referred to, but also in the Kolek or "sea canoe" of Singapore, in which also the old Malay lug has been altogether discarded, especially for racing purposes, in favour of the sprit sail. The stay sail is recognised as the most convenient form of head sail, to prevent excessive griping, and does not involve the disadvantage of the weight of a mast right in the eyes of the ship.

Rua Layap
Close hauled.
Singora Harbour.

It will thus be seen that, from a variety of causes, with which the physical geography and the meteorology of the locality have much to do, the canoe shape, the canoe idea, predominates in most of the boats of the Malay Peninsula, it may, in fact, be said that the maritime enterprise of its inhabitants obviously commenced with the canoe and continued with the canoe, and that its highest form of development has resulted in a craft of larger dimensions, which yet in all essential particulars still remains—a canoe.



at anchor

from a sketch off Lakawn

The nomenclature employed by the Malays for their boats appears to the traveller at first to be unnecessarily intricate. Closer attention, however, soon shows that the name, as has indeed been already suggested, is very rarely derived from the rig, as is so much the case in Europe, but rather from distinctions, which often seem to the stranger to be comparatively insignificant, in the hulls or build. Nearly every water-side settlement of any importance having developed its own ideas of ornamentation or of construction, it is not to be wondered at, that boats, which might well be classed under one head, as far as all essential particulars are concerned, yet come under the observation of the traveller under widely different names, differing often merely with the locality of their origin. For instance, a number of otherwise very similar boats are named (*a*) simply after the form of figure-head, to the frequency of which reference has already been made, *e.g.*, the Hornbill-boat,* the Crocodile-boat†; or (*b*) from some peculiarity in construction, *e.g.*, the Patani "Half-decked"‡ boat (literally, Boat with decked fore-part),‡ or the "civet-fence§" boat, which is nothing but a

A Kelentan
type of Sea
Canoe

In Singapore
Roads

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* "Prahu Enggang."

† "Prahu Buaya."

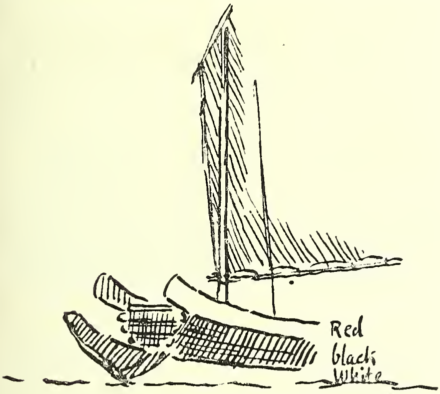
‡ "Katop 'Luan."

§ "Pagar Tenggâlong."

form of the type generally known as "Penjajap," to which a peculiarly ornamental bulwark or rail is given.

A large number of boats, as might be expected, are distinguished by the use for which they are built—*e.g.*, the "boat for going up-stream,"* and various types of fishing boat;† others are of purely local significance—*e.g.*, Banting [an Achinese type],—while several appear to be derived from European names—*e.g.*, "skonar" [schooner], and "pinis" [pinnace], and perhaps "kichi" [ketch], "skuchi" [scotchy], and "katar" [cutter].

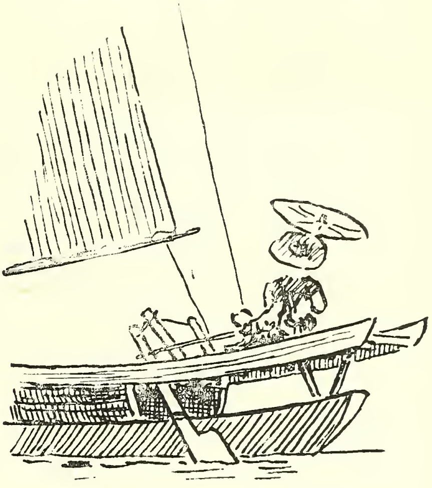
It is noticeable that, in most of their larger built boats, the Malays have adopted the comparatively modern method of slinging the rudder by metal fastenings on the stern post, known afloat as "gudgeons" and "pintles."



Bow
built up dugout.

In many of their dug-out canoes, in the kolek, and some of the non-Europeanised types of fishing boats‡ of Selangor and the East Coast, for instance, the rudder consists of the simple paddle held on the quarter, or a paddle-shaped rudder slung at the head on a stout upright, and held at the neck by a rattan lashing. This is the earliest and simplest form of rudder known to man. It was that used in the ships of the earliest navigators of the Mediterranean, of whom we have record,§ and it remained, with slight modifications, as the usual steering contrivance of the Egyptians, of the Greeks and Romans, and of the Danes and Saxons and Normans, down to mediæval times. It is much used in some of the craft of the Northern portion of the Gulf of Siam, and it may be noted that the rudder is always used on the lee quarters, if, as is usual, the boat carries a weather helm, this position giving far greater power and deeper immersion.

The Malays do not use oars to a great extent, except with the bigger decked vessels. These oars are somewhat heavy about the loom, and have often sharp pointed blades, shaped rather like a broad angular spear head. They are generally worked in a rattan grommet, to a sharp quick stroke, any other kind of stroke being impossible, owing to the friction in the grommet, and the shortness of the oar. The "standing up and pushing" (or "salmon-stroke") position, common with the Siamese and Chinese, and in the Mediterranean, is on the whole, rarely adopted by the Malays. In the smaller craft, with low free-board, the paddle is used, the blades in some localities having the same angular spear shape.



Stern
built up dug out.

BOAT BUILDING.

The Malays usually follow the general Indo-Chinese method of construction, in the first stages, at all events, of their smaller boats.

A selected tree is laboriously hollowed out by the adze, until the sides are sufficiently thinned to open out under pressure, and the judicious application of heat, by a slow burning ember fire beneath the bottom. The fore and after ends are roughly modelled with the adze. Before proceeding further, the hull is at this stage frequently soaked for some days in the water. In many parts of Siam and Burma, the presence of a monastery can almost be certainly predicted by the little fleet of hewn modelled hulls lying sunk beside a landing place, a sure sign of the boat-building propensities of the brethren of the yellow robe close by. When sufficiently soaked, the opening out process begins.

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* Prahu pemudik, from mudik; to go up-stream.

† Prahu ikan, or per-ikan, from ikan; fish.

‡ *e.g.* the Kakap Jeram.

§ We have records of craft in Egypt so steered from the time of the Third Dynasty (about 6,000 B.C.)

Dug-out boat being opened out.—Various methods are used for this purpose. In this case water is placed inside the dug-out hull, and hot embers are placed upon the ground underneath her, and kept at the required temperature, until the sides have opened out sufficiently to take ribs, knees, and crosspieces. The sides in falling out come down to the bow and stern, and your up-river canoe is now complete.

with fair monsoon,

from a sketch in the Gulf of Siam.

1. Sampan s'lit, a dug-out canoe with wash strake raised on the inside.
2. Chemplong, a fairly deep bodied canoe.
3. Jalor, a shallow dug-out canoe.

Another method of opening the dug-out hull is often used. To the perpendiculars on each side crosspieces are securely lashed under the hull. A similar number of crosspieces are placed above the hull over the lower ones, and connected by a strong double rattan rope. Through these rattans hardwood levers or handles are placed to give a purchase, and are then twisted round and round, bringing the ends of the crosspieces together. This pressure is kept constant, while water and hot embers are applied as necessary.

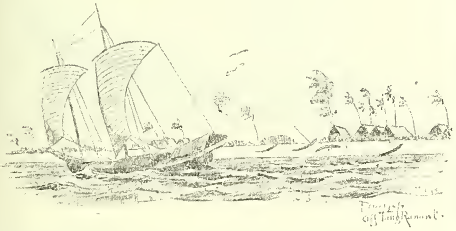
Two dug-outs may sometimes be seen being cut from one log; the inner and smaller one is worked out by the driving of stout wedges. In order to facilitate the heavy work of driving home these wedges, a low scaffolding is erected alongside one of the canoes, for the wedger to stand upon, and the log itself is turned over till it lies at a convenient angle, by means of a lever placed underneath it, the end of the lever raised by a rope made fast to a windlass. Sometimes a simple floor or keel-piece is used, on which the boat is subsequently built up. In this case stem and stern pieces will be worked in. The sides are rabetted into the floor piece, and the upper strakes built on as in an ordinary carvel-built boat. The simple dug-out form having been obtained, the upper strakes can be built on, the ribs being carried up to receive them. For this purpose the planks are bent by various ingenious applications of levers and hot embers. Many clever devices are used by the Malays for getting the necessary power, and the boat-builder has many arrangements of stout upright pegs about his shop or in his compound.

Fishing canoe,
Singora.

In the inland sea of Singora, many dug-outs may be seen, built up with strake on strake, in the most unblushing way, without any attempt to hide the roughest method of boat building, perhaps to be seen anywhere. No attempt is made to work in stern and stern posts. The ends are blocked across a foot or two inside

Malay trader
with Chinese lugs.
close hauled.
East Coast

the end of the boat's nose or tail, if one may use the expression, thus forming thwart-ship water-tight bulkheads. The two or three strakes, often various coloured, are built on, and the topmost one is utilised to give a finish to the whole, by being extended and turned up forward, and carried out to form a steersman's staging some way aft. The almost submerged noses of these boats, which are really more Siamese than Malay in type, have generally a most pathetic expression. These boats draw very little water, and are used all over the lake, being able to navigate the shallows which now form so large a portion of it. They are usually rigged not with the Malay lug, but the Siamese high-pointed standing lug, a far handier and handsomer sail. For these, the very light yellow matting is used, which is almost universal in the upper portion of the Gulf of Siam.



In another method of warping planks by aid of a fire, when the planks are ready to go on as upper strakes, they are fixed in position, and built up upon the dug-out keel and floor portion of the boat, which has already been opened out to the required extent, as described. The strakes, as they are put on, are held in position by a system of bamboo ties, and secured by rattan lashings. The last stages of the Malay boat differ with the district. In many cases a beautiful finish is given to the fittings, and a shining polish to the underwater portion of the hull. At this stage half the village may be found at the boat-builders, polishing or criticising with much energy and enthusiasm.

APPENDIX.

I.—List of Boats.

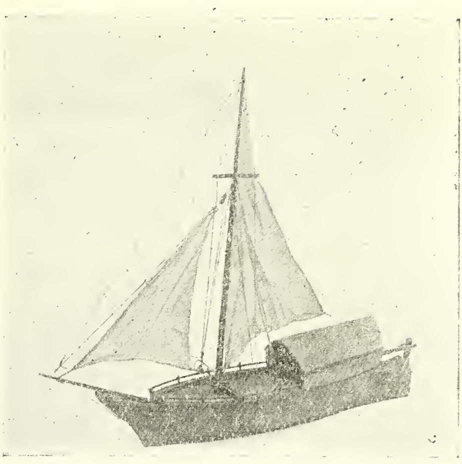
1. Balok*.—A single-masted lugsail boat. The model suffers from a mast which is too short to hoist the lugsail. The boat has good beam, and fairly flat floors. There are washboards at the quarters, and a peculiar slightly outrigged grating or staying over the stern post. The rudder is very small and short, and has a yoke and lines.

2. Bedar or Bidar*:—From shape of stemhead or beak; built of chengal; length, 24 ft. beam; 4 ft. depth of hull; 2 ft. freeboard; 1 ft. capacity; 1 koy; number of crew, 3; oars only.

3. Bandong.—Built of merawan; dimensions, 54 ft. by 6 ft. by 3 ft.; 13 ft. freeboard; capacity, 2 koy; crew of 5; length of mast, 50 ft.; cloth lug sail.

4. Banting† (Achin, Sumatra).—A two-masted trader, built of giam wood; dimensions, 90 ft. by 27 ft. by 7 ft.; 2 ft. freeboard; capacity, 12 koy; crew of 6; length of mainmast, 50 ft.; sails of cloth, but rig uncertain.

5. Bermat (Gelmat).—A type of boat frequently seen in tidal waters on the west coast. Has one mast; carrying a square-headed dipping lugsail of the usual type; also a small, roughly-made gallery aft, which amounts to little more than an out-rigged seat, and is fitted with a steering paddle in place of a rudder. Length of this model is 19 in.



Gubang Bugis.‡

6. Gubang§ (Bugis or Celebes).—The hull of this model shows a lot of dead-wood aft, and a lack of body abaft the midship section. A clipper cutwater, a long, straight bottom, narrow quarters, leading to a perpendicular stern-post, do not combine to make a handsome vessel, or to satisfy one as to the accuracy of the model. The rig is a European adaptation, scarcely satisfactory except when beam-winds are available.

7. Chemplong (Sumatra).—A long paddling canoe, built of jati. Dimensions, 60 ft. by 5 ft. by 2 ft. 3 in., 1 ft. freeboard; capacity, 1 koy; crew of 12; oars only.

8. Gubang ("pirate" boat).—The gong is usually

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* Klinkert says, a trading vessel of great tonnage formerly used.

* Klinkert says, a small, single-masted sailing boat, also used as state boat by Princes.

† Klinkert says, a two-masted Achinese vessel.

‡ This and the other illustrations in the Appendix are from the models in the Cambridge Archæological Museum.

§ Klinkert says:—"A small sea vessel, exceedingly seaworthy. In reality it is no doubt much more so than in the model."

hung just forward of the deck-house. This model is chiefly interesting as showing what in old days was a very formidable type of sea rover, or pirate, propelled chiefly by oars and armed with swivel guns of considerable size in the bows. A stout timber breastwork forward gave shelter to the crew when as usual the attack was made end on.

9. Gurap.—One of the largest Malay traders, fore and aft rigged on two masts; material, giam; dimensions, 300 ft. by 30 ft. by 20 ft., 11 ft. freeboard; capacity, 100 koy; crew of 30; length of mainmast, 100 ft.

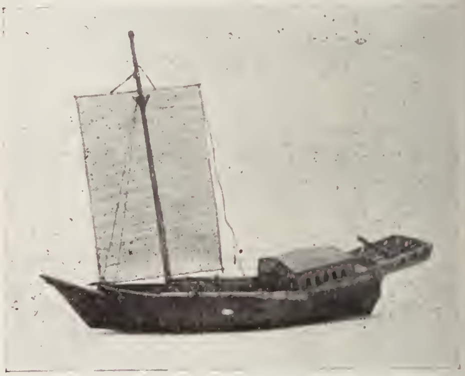
10. Jalak.—The Pahang name for the ordinary east coast two-masted Penjajap-rigged trader, known as Payang at Trengganu. The main proportions are the same, as is the rig, but there are local differences in build of hull, though the material is the same giam wood, and the general appearance practically the same. Dimensions, 72 ft. by 12 ft. by 9 ft.; 4 ft. freeboard; capacity, 2 koy; crew of 8; length of mainmast, 36 ft. in this instance. The lugsails are of the usual screw-pine leaf.

11. Jong (junk).—A large type of trader, having mainmast, foremast, and possibly mizzen; built of jati; dimensions, 200 ft. by 29 ft. by 18 ft.; 10 ft. freeboard; capacity, 50 koy; crew of 24; length of mainmast, 90 ft.; said to carry "gusi" sail. According to Klinkert, this may be "bezaan" mizen, or "gaffelzeil," fore and aft gaff sail, as distinguished from Chinese or Malay lug. The probability is, that this craft is always rigged with fore and aft sails. For in this case topmasts are always used by the Malays, while with the lug sails, pole masts are used. The length of the mainmast given almost precludes the latter.

12. Jong Batubara.—Built of chengal; dimensions, 90 ft. by 24 ft. by 16 ft.; 7 ft. freeboard; capacity, 15 koy; crew of 9; length mainmast, 90 ft.

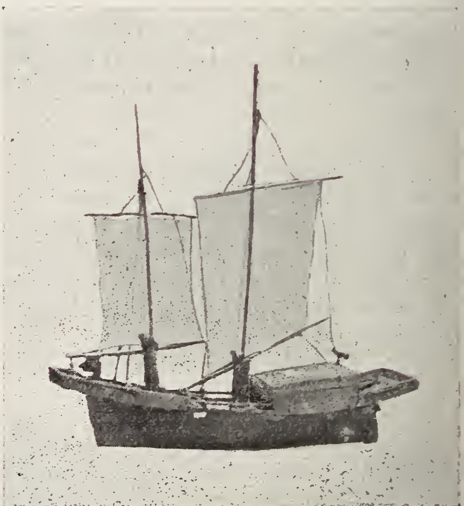
13. Kakap Jeram* (native Selangor coast fishing boat).—A typical Malay fishing boat of the Selangor coast. The rig is practically the same as that of the Nadir. The model shows the figurehead, and ornamented stern post, and the long paddle rudder already described. The gratings on which the crew are accommodated are shewn, and along each side forming the gunwale may be seen a wash-strake formed of strong lacing of split bamboo strips, stoutly sewn together with bamboo withies, and filled in with palm leaf, the whole held in position by lashings to knees brought up from the boat's ribs. This is a very usual form of wash-strake in Malay boats, and is strong, and light, and effective. It is given considerable flare at each quarter. The equivalent of the lumber irons used in European fishing craft is provided by loops of rattan on the starboard side, and here the punt poles, and other spars are stowed. Forward will be noticed a peculiar form of bits, stretching athwart ships, used for winding the cable upon, as well as bitting it. Dimensions, 13 ft. by 7 ft., by 3 ft.; 1 ft. freeboard; capacity, 2 koy; crew of 3; length of mast, 23 feet; material, meranti.

14. Katar.—Built of jati; dimensions, 180 ft. by 21 ft., by 9 ft.; 4 ft. freeboard; capacity, 20 koy; crew of 10. Length of mainmast, 90 ft. Said to be one-master. Though the name resembles our word cutter, one cannot suppose a Malay vessel of such dimensions is cutter-rigged. The Malays are not accustomed to use material of sufficient strength to stand the enormous strains that would be involved.



KETIAP.

15. Ketiap (trading river boat, built of giam).—Dimensions, 48 ft. by 9 ft. by 3 ft.; 1 ft. freeboard; capacity, 2 koy; crew of 3; oars and poles only.



KETIAP AYAM.

16. Ketiap Buaya (Katar).—A cutter-rigged river boat, carrying a figurehead representing a crocodile, and an outrigged gallery. It was propelled by sweeps. The length of this model is $21\frac{1}{2}$ in.

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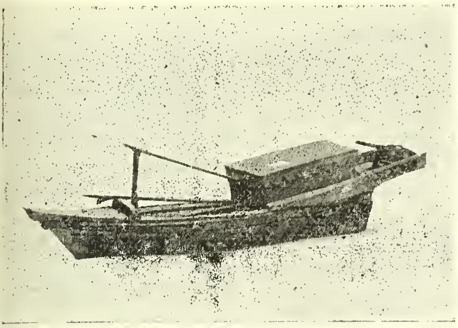
* Kakap means "spy" or "scout," or "look-out," and Jeram is the name of a big fishing-village in the Kuala Selangor district (of Selangor), from which this boat took its name of the Jeram Scouter.

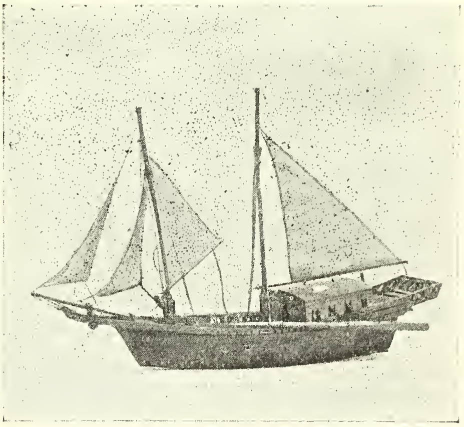


Ketiap Pengallak.

17. Kichi (large two-master). — Material, jati; dimensions, 200 ft. by 30 ft. by 15 ft.; 5 ft. freeboard; capacity, 60 koy; crew of 20; length of mainmast, 80 feet; said to be rigged with yards, brig-rig. Klinkert says: English brig or yacht. Some of the Malay Peninsula Rajahs have at various times owned very fine European built and rigged vessels half as traders half as yachts. A very handsome brig belonged to an East Coast Rajah a few years ago.

18. Kolek[*] (lit. the "Rocker" or wobbler, from its crank build).—The term "sampan," a word of apparently Chinese origin, which is given generally to any small, especially Chinese, boats, is also frequently applied to these canoes. The kolek is the usual form of small sea-fishing canoe, the stem and stern-post are generally high and pointed, with some decorative paint work, or other ornamentation. It is generally carvel-built, with a shapely hull, and prettily rounded forefoot; but there is very little bilge, and consequently small stability, which, combined with the low canoe-like freeboard, makes these boats somewhat tricky to the novice. The peculiar "crabs'-eyes" are frequently to be seen in these boats. They carry single or double lug sails according to length. In the former case, the tack of the sail is usually belayed at the mast, so as to form a standing sail. In these little boats the young Malays generally got their first lessons in sailing. In the longer boats, with larger crews, two dipping lugs of the usual Malay type are generally preferred. Dimensions of 5-man boat:—Length, 24 ft.; beam, 4 ft.; depth, 2 ft.; freeboard, 1 ft.; capacity, 20 pik; length of mast, 24 ft. Some of these boats are said by the Malays to carry the "sabang" sail. Klinkert describes this as "the sail of a small boat which has no tackle except a brace, but has instead a kind of 'sokong' [= prop]." This presumably means a sprit-sail, set up by its sprit—no other sail so exactly answering to this description. In Singapore, the koleks have developed into long boats used a good deal in racing, rigged with large cloth-made spreet mainsail and stay-foresail, and manned by a large crew of 20 or more, who act as live ballast out to windward. In a fresh breeze they stand on the gunwale, and, holding on to man ropes leading from the mast, lean out all their length to windward. These boats are very slippy with the wind abaft the beam, for, with a length of 45 feet, they have a beam of not more than 5 ft. 6 in., and a draught of about 2 ft. But they have no grip for weatherly work. The increase of the lateral resistance, by the introduction of a centre-board, would probably result in enabling these boats to perform well on a wind in smooth water.

19. Lancha[*] or Lanchang[†] (Malay two-master, with dipping lug-sails).—This is an approach to a sea-keeping type of vessel. She is rigged with the ordinary square-headed dipping lug sails, which are of nearly equal size as in the Penjajap. The lofty slender masts are well stayed, and are stepped in tabernacles of a kind which is common to the Malays, and both are raked forward. The sails are made of the screw-palm with cloth tops, and there are main and peak halyards. The vessel has a clipper stem, over which the fore-gallery is built for the anchors; this also acts as a bumpkin or bowspit for spreading the tack of the foresail. A comparatively commodious deck-cabin and stern gallery are added over the straight stern post. The hull is carvel built on very European lines, but has no great depth. The model is armed with pivot m. l. guns, and has sweeps along her sides as is usual.



Lancha.

N.B.—In Selangor it is affirmed that the Lanchang is a type of boat which was frequently owned by Malay Rajas on the Sumatran coast, and to this day in Selangor, it is this royal vessel which is dedicated to the service of the spirits, when the medicine man invites them to sail away.

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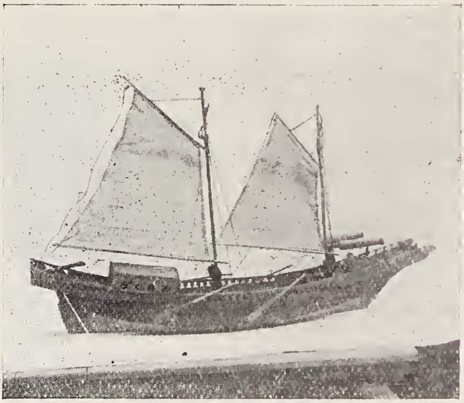
[*] Klinkert says:—"The small variety for one person only; but big ones hold 10 or more persons."

[*] Klinkert says:—"Big Indian three-master, with slanting or sloping sails from port; Lancha, boat or sloop." (See Lanchang.)

[†] A galley or oared vessel with yards, but without "spiegel."—Klinkert.

20. Lanchang To'Aru[*] (Bandar). — Malay two-master, fore and aft rigged. This is very similar to the other Lanchang in hull, but the model has short masts, and two badly cut and fitted fore and aft gaff and boom sails. She would need very much a larger spread of head canvas, and boats thus rigged on the east coast generally carry long topmasts and jibbooms for light-weather sails.



Lanchang To'Aru.

21. Nadir.—This is another more Europeanised Malacca type, with cloth sail and weather boards astern.

22. Nadir.—A shallow-draft Malay fishing-boat of the Malacca coast, carvel built, and with straight stem and stern posts of European type. The rig is a single lug, the tack or fore-end of the boom being made fast well forward, and to windward of the mast. The luff is set taut by a spar-bowline fitting in a cringle, the after-end coming to the deck abaft the mast. There is a peak as well as a main halyard, both in single parts. the sheet and vang being the same, and leading to the helmsman aft. There are spear-bladed paddles, and in the model the "Kadjang," or attap-thatch shelter, used by the crew when riding to an anchor, is shown rolled up on the gratings. The sail is reefed by rolling round the main boom by help of a wooden pin used as a lever, from the fore-end to the height required. A rope parral, as is usual, keeps the sail to the mast. Such a boat would be enormously improved by centre or lee-boards. Material, kelidang; dimensions, 24 ft. by 6 ft. by 3 ft. 3 in.; 1 ft. freeboard; capacity, 1 koy; crew of 5; length of mast, 30 ft., screwpine-leaf sail.

23. Pedewak[*] (Bugis, Celebes).—A two-masted trader. Built of giam wood. Dimensions, 99 ft. by 15 ft. by 12 ft.; 6 ft. 3 in. freeboard; capacity 60 koy; crew of 16; length of mainmast, 60 ft.

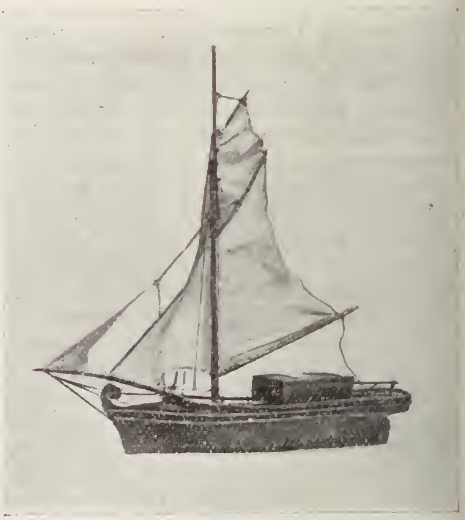
24. Payang.—This is a type which has a divided deck-house. The Payang has usually the ordinary two-lug rig, and dandans fore and aft. Dimensions, 72 ft. by 12 ft. by 5 ft.; 3 ft. freeboard; capacity, 4 koy; crew of 4 men; material, giam; sails of screw palm-leaf; length of mainmast, 60 ft.

25. Pelang[†] (a large canoe-like boat, built of giam wood).—Dimensions, 42 ft. by 5 ft. by 2 ft. 3 in.; 1 ft. freeboard; capacity, 1 koy; one mast about 40 ft. long with cloth lug sail.

26. Penchalang (Bugis Celebes)—A two-masted trader, built of jati. Dimensions, 80 ft. by 15 ft. by 9 ft.; 4 ft. freeboard; capacity, 15 koy; crew of 30 (?). Apparently European rigged, the masts having ratlines.

27. Pemudik.—A river boat, built of seraya. Dimensions, 48 ft. by 15 ft. by 2 ft.; 6 in. freeboard; capacity, 2 k. 20 p.; crew of 5. Carries no awning.

28. Pinis.—Built of penak wood. Dimensions, 120 ft. by 27 ft. by 8 ft.; 3 ft. freeboard; capacity, 30 koy; crew of 9. The masts: mainmast 50 ft. long.



Pinis.

29. Prahu (Ayam Cock boat).—So-called from its figurehead. In other respects it differs little from other forms of Malay river boats.

30. Prahu Buaya (Crocodile boat).—So-named simply from its figurehead. She has a stern gallery, a kadjung for the passengers, and four oars, with mast

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[*] To'Aru was one of the council of four great chiefs of Selangor, who in former days had much power, and to whom was entrusted the election of the Sultan. To'Aru was the most powerful of these four great chiefs, and took his name from a district called Aru, in Sumatra, from which he came over to settle in Selangor. Aru is probably the same as the word Aru (also eru or 'ru), which means a casuarina-tree. Bandar was the name of the place (on the Langat river) where To'Aru lived.

[*] Klinkert says: "Pedewakan—A Bugis trading vessel."

[†] Klinkert says: A flat-bottomed vessel. Chinese Pilan.

and sail. The rudder is hung upon the stern post. Length of model, 23 in.

31. Prahu Enggang (Hornbill boat).—Named after ts figurehead. The boat has a stern gallery, and the peculiar, but not uncommon, divided deck shelter aft. As regards her rig we may charitably suppose that he skipper, having been dismasted in a squall, has borrowed or stolen his mast and sail from a passing kolek.

32. Prahu Kumbang or "Borer-bee boat" (Royal barge from Selangor).—The gong is usually suspended from the ridge pole aft.

33. Prahu Naga or "dragon" boat.—A two-master with the ordinary square-headed dipping lugsails, and deck-house rudder, and galleries both fore and aft. The name of this boat, which means dragon, is taken from its figurehead which represents a dragon. It is said to be of a type formerly used by Malay Rajas, *e.g.*, by the Sultans of Perak and Selangor. The length of this model is 27 in.

34. Prahu Penggalah (a river boat of Kelantan type propelled by from four to six quanters).—The quanting poles when out of use are slung under the eaves of the deck-house, which is very low and entirely unprovided with windows. The quanters stand in pairs on the outrigged staging over the bows, and when the first pair have planted their poles they walk rapidly down towards the door of the deck-house pushing hard as they go. Immediately behind them come the second pair, and behind them come the third, each pair as it comes to the end of its walk lifting the poles over the heads of the succeeding pairs, and returning to the fore-end of the staging referred to. Length of this model about 19 in.

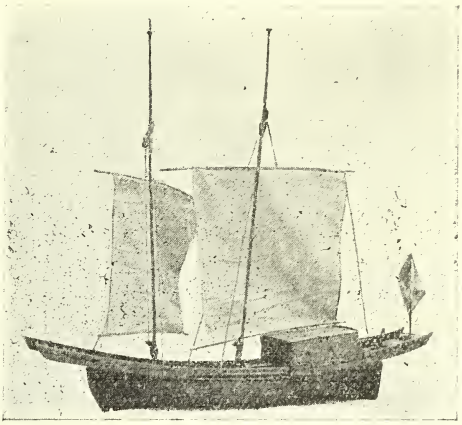
35. Prahu Pêlet (Eng. Pilot).—A thorough-going Malay as regards hull, with a low-cut imitation of an European gig's dipping lug, with the addition of the usual Malay boom and the vang to the yard. These vangs are always necessary owing to the sails not being of sufficiently stout material to carry a stout luff-rope, by which the sail can be set up taut to stand on a wind.

36. Prahu Jolong-jolong (lit. Long-beaked boat, from her cut-away fore-foot, and clipper stem).—She has the galleries shared by most of the large decked Malay boats. The rigging of the model is, as will be seen, somewhat faulty, but is sufficient to show that the ordinary two lug of the Penjajap and her sisters is used.

37. Prahu Tambang (*i.e.* passenger or ferry boat).—Has the bows prolonged into a sharp beak, mast and shoulder-of-mutton sail, outrigged seat for the steersman, and washboards astern. The steersman's seat is called "ketam kemudi" (lit. rudder-crab, from a supposed resemblance between its shape and that of a crab). The rudder is hung European fashion. The length of this model is 20 in.

38. Salah-Salah.—A large three-master, being fore and aft rigged on two masts, with yard or "peruan" (square or lugsail) on the third. Built of kelidang. Dimensions*—240 ft. by 30 ft. by 15 ft.; 5 ft. freeboard; capacity, 30 koy; crew of 20; length of mainmast, 80 ft.

39. Skonar (Qu. schooner).—Built of jati; dimensions 180 ft. by 26 ft. by 12 ft.; 4 ft. freeboard; capacity 40 koy; crew of 10. Described as being rigged on fore and main masts with yards, and third mast with "gusi" sail (mizzen or fore and aft sail). It would appear that the two forward masts either carry lugsails or square yards. The mizzen would be a fore and aft sail. This might be a barque-rigged or Chinese-rigged vessel.



S'KUCHI.

40. S'kuchi or skochi†.—A two-masted trader. Dimensions 50 ft. by 15 ft. by 7 ft.; 3 ft. freeboard; capacity 10 koy; crew of 8; length of mainmast 40 ft.; lugsails of screw palm leaf, of usual type.

41. Tongkang Malayu (Malay lighter).—This ketch-rig is now much used in the cargo lighters of Singapore, and is a handy one for a small crew, working about a crowded anchorage liable to sharp squalls. Mainsail and mizzen are set by an outhaul along the gaff, and are easily and rapidly taken in by being brailed to the mast. Many of these boats may be seen any day working in Singapore roads. There is also a class of lighter in Singapore rigged with a big flat-headed lugsail, somewhat like similar lighters at Rangoon. They are big powerful boats, well suited to their work. The rig is handy for going alongside ships, as involving very little gear.

42. Top or Tôb.—A two-master, built of giam wood. Dimensions, 90 ft. by 18 ft. by 8 ft.; 4 ft. freeboard; capacity, 15 koy; crew of 8; length of mainmast, 60 ft. Probably a fore and aft schooner rigged-vessel, being described as having the "gusi" sail. But if the word means "mizzen," the rig is left open.

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* Probably over-all length to end of dandans or galleries.

† Klinkert says: from Dutch schuitze, used for any small sailing boats of European rig?

43. Tunku Kudin's Barge (Kedah pattern), called "Kempeng" or "Ketiap Kedah."

44. Wilmana (from the name of a fabulous bird), an obsolete type of State-boat, formerly used by Selangor Rajas. The particular boat from which this model was copied belonged to one Ungku Alang. A river boat propelled by sweeps, and fitted with an awning for the crew, as well as for the passengers. It has outrigged galleries fore and aft, and carries a flag and royal gong. The length of this model is 32 ins.

II.—Tables of Boats (*a*).

No.	Name of boat.	Material.	Length.	Beam.	Depth (of hull).		Tonnage.		Freeboard.		Crew.	Masts.		Material of sails.	Remarks.
		Name of wood.	Feet.	Feet.	Feet.	Inches.	Koyan.	Pikul.	Feet.	Inches.	No.	No.	Height in feet.		
1.	Bedar.	Chengal.	24	4	2	0	1	0	1	0	3	...	...	...	Oars only.
2.	Ketiap.	Giam.	48	9	3	0	2	0	1	0	5	...	...	...	Oars and poles only used for trading u the rivers.
3.	Pemudik.	Seraya.	48	15	2	0	2	20	0	6	5	...	...	...	Carries no awning open river boat.
4.	Nadir.	Kelidang.	24	6	3	3	1	0	1	0	5	1	30	screw-pine (mengkuang)	Leaf.
5.	Payang.	Giam.	72	12	5	0	4	0	3	0	40	2	60	do.	
6.	Kakap.	Meranti.	18	7	3	0	2	0	1	0	3	1	23	cloth	
7.	G'lemat.	Merbau.	36	8	2	3	1	0	1	0	3	1	36	cloth	
8.	Skuchi.	Kelidang.	50	15	7	0	10	0	3	0	8	2	40	screw-pine leaf	
9.	Jong.	Jati.	200	29	18	0	50	0	10	0	24	2	90	cloth	"Gusi" sail.
10.	Jong (Batubara).	Chengal.	90	24	16	0	15	0	7	0	9	2	90	cloth	
11.	Salah-Salah.	Kelidang.	240	30	15	0	60	0	5	0	20	3	80	cloth	1. Mast, with yar (peruan); 2. Mast with gaff topsail (ga topsir).
12.	Gurap.	Giam.	300	30	20	0	100	0	11	0	30	2	100	cloth	Same as No. 11.
13.	Kichi.	Jati.	200	30	15	0	60	0	5	0	20	2	80	cloth	Two masts, with yards
14.	S'konar.	Jati.	180	26	12	0	40	0	4	0	10	2	70	cloth	Two masts (*fore an* *main*), with yards third mast wit "gusi" (gaff topsail)
15.	Penchalang (Bugis).	Jati.	80	15	9	0	15	0	4	0	30	2	60	cloth	Masts furnished wit ladders (? tangga (possibly Europea "shrouds").
16.	Chemp-long.	Jati.	60	5	2	3	1	0	1	0	12	...	...	(none)	Oars only.
17.	Bandong.	Merawan.	54	6	3	0	2	0	1	3	5	1	50	cloth	
18.	Pedewak (Bugis).	Giam.	99	15	12	0	50	0	6	3	16	2	60	cloth	
19.	Pinis.	Penak.	120	27	8	0	30	0	3	0	9	2	50	cloth	
20.	Katar.	Jati.	180	21	9	0	20	0	4	0	10	1	90	cloth	
21.	Banting (Acheh).	Giam.	90	27	7	0	12	0	2	0	6	2	50	cloth	
22.	Pelang.	Giam.	42	5	2	3	1	0	1	0	5	1	40	cloth	
23.	Top.	Giam.	90	18	8	0	15	0	4	0	10	2	60	cloth	"Gusi."
24.	Jalak (Pahang)	Giam.	72	12	9	0	2	0	4	0	8	2	36	screw-pine leaf	"Awning fixed permanently astern aske (?)."
25.	Kolek.	Seraya.	24	4	2	0	0	20	1	0	5	1	24	cloth	"Sabang" (sprit) sail (?

TABLES OF BOATS (*b*).

Name of Boat. (Nama prahu.)	Length. (Panjang-nya.)	Beam. (Awak-nya.)	Draft. (Brapa kaki dalam makam-nya.)	Freeboard. (Brapa kaki tinggi-nya deri pada ayer.)	Cargo. (Muatan-nya.)	Number of Crew. (Orang-nya.)	Number of Masts. (Brapa tiang-nya.)	Remarks.
Sampan	4 depa	4 kaki	1½ kaki	1 kaki	6 pikul	2	...	...
(1) Galor	3 ,,	3 ,,	½ ,,	½ ,,	3 ,,	1	...	...
(2) Sagor	25 ft.	5 ft.	1 ft.	3 ft.	6 ,,	3	1	...
(3) Kolek	3 depa	6 kaki	1 kaki	1½ kaki	6 pikul	1	...	...
Badar	4 ,,	5 ,,	1½ ,,	2 ,,	6 ,,	4	...	...
Ketiap	30 ft.	6 7 ft.	1 ft.	2 ft.	1½ koyan	5	...	...
Pemudik	35 ft.	7 ft.	1 ft.	3 ft.	2 ,,	6	...	...
Nadir	20-25 ft.	6 ft.	1½ ft.	4 ft.	1 ,,	4	1	...
Payang	48 ft.	7 ft.	2 ft.	3 ft.	2½ ,,	12	2	...
Kakap	5 depa	1½ kaki	2 kaki	1½ kaki	5 ,,	5	...	...
Bermat	...	...	...	...	...	...	...	...
Skuchi	50-60 ft.	8 ft.	3 ft.	5 ft.	5-6 ,,	6	2	1 jib
Salah-Salah	72 ft.	10 ft.	5 ft.	7 ft.	10 ,,	8	2	2 jibs
Jong	12 depa	2½ depa	5 kaki	6 kaki	10 ,,	6	3	...
Tongkang-Malayu	35 ft.	6-7 ft.	2 ft.	5 ft.	2 ,,	5	2	...
Gubang	4 depa	4½ kaki	1 kaki	4 kaki	8 pikul	3	1	...
Penjajap (labak bergantong)	7 ,,	1½ depa	2 ,,	4 ,,	5 koyan	4	1	...
Balok	30 ft.	6 ft.	1 ft.	2 ft.	1½ ,,	5	...	...
Gebang	10 depa	2 depa	2½ kaki	5 kaki	7 ,,	5	2	...
Lancha	5 ,,	1 ,,	1½ ,,	4 ,,	5 ,,	4	1	...
Lanchara Lanchara	10 ,,	2 ,,	3 ,,	5 ,,	8 ,,	6	...	...
Prahu-Tambang, etc.	18 ft.	5 ft.	½ ft.	2 ft.	1 ,,	2	1	...
Kolek lumba (Singapore)	6 depa	1 depa	1½ kaki	4 kaki	4 ,,	3	1	...

III.—LIST OF PRINCIPAL WOODS USED IN MALAY BOAT-BUILDING.

Malay Name.	Botanical Name.	Names of Boats in which they are used.
1. Chengal or chengai	....	Bedar, Jong Batubara.
2. Giam	Shorea sp. (in Sumatra), Balano carpus sp? (in Malay Peninsula)	Ketiap, Pelang, Payang, Top, Gurap, Jalak, Pedewak, Banting Acheh.
3. Jati	(Teak) tectona grandis	Jong, Kichi, Skonar, Katar, Chemplong, Penchalang Bugis.
4. Kelidang or K'ledang (sel.)	Artocarpus lancifolius	Nadir, Skuchi, Salah-salah.
5. Meranti	Hopea meranti	Kakap.
6. Merawan	Hopea mengarawan	Bandong.
7. Merbau	Afzelia palembanica	Gelemat (Bermat?).
8. Penak	Balanocarpus maximus	Pinis (?).
9. Saraya or Seraia Chempedak ayer	Shorea	Pemudik, Kolek.

P.S.—Among the many other woods used in Malay boat-building may be mentioned the several species of "Medang" (tetranthera), and mentangor (calophyllum), used especially for masts and spars, &c.; also perhaps the Indian daun (Shorea); K'ranji (leguminosæ and dipterocarpeæ); and Kosak or Kusak (dipterocarpeæ); Penaga (calophyllum inophyllum) is used especially for "boats'-knees" (siku-siku); Perepat (sonneratia alba ?); Pudeh (calophyllum inophyllum) for big boats, especially stem and bow pieces, not planks; Bentangor bunga for masts (calophyllum pulcherrimum); glam-bark (melaleuca leucodendron) and damar, instead of oakum and pitch.

IV.—GLOSSARY.

Andang-andang.—The "yard."

Anjing-anjing.—Lit. the "Dogs"; tack-ring for sail fixed in *chabang guling* (*q.v.*).

Angkul-angkul.—Metal ring for setting up stays to, or belaying tack of sail (both fore and aft). When these rings are of wood, they are called anjing-anjing *q.v.*; *e.p.* also the other use of the word angkul-angkul (in *kolek*).

Angkul-angkul.—The ornamental "bit" across the stem of the sea-canoe (*kolek*) only, with "crab's eyes" lashed in position; *v.* angkul-angkul (supra).

Apit lempang.—Lower strake.

Balas.—(*v.* Tolak bara).

Bantal.—Lit. pillow; *i.e.*, "rest" or "support."

Batang (*dayong*) or *gandar.*—The shaft of an oar.

Batu sauh.—Lit. "anchor-stone," *i.e.*, weight lashed to shank of Malay anchor as a "sinker."

'Bam (*kamudi*).—Rudderhead.

Bêdar.—An elongated and flattened beak, broadening towards the tip (not unlike the bill of an ornithorhyncus). *v.* also list of boat names.

Bekas pengumpil.—Crutch for helmsman's steering oar or paddle.

Bekas Tombak sayang.—Cringle in the luff taking spar-bow-line.

Bengku-bengku (*kajang*).—Crutches or solid forks for supporting awning (kajang), stepped in "joints" (internodes) of bamboo: native (Malay) awning rests for supporting *sides* of awning only.

Beranda.—Gallery or deckhouse, lit. "verandah" (perhaps from the Portuguese).

Berombong.—Mast-tabernacle.

Birei.—"Side" of a boat (*i.e.* a thin, sharp boat-side as distinct from a boat-side with broad gun-wale, for which latter *v.* leper-leper).

Bom (Dutch).—The "Boom."

Buah berembang.—The Truck (lit. "*berembang*" fruit, so-called from an onion-shapened fruit which grows on a big tree in the tidal mangrove swamps). In Jav. Berembang *v.* onion. The fruit is acid and may be eaten.

Buaya-buaya.—Lit. the Crocodile. The posts at bow and stern of some Malay boats, which are nailed to the linggi (*q.v.*).

Chabang guling.—Horizontal forked bow-and-stern gunwale—pieces.

Cherok jegong.—Locker under bow-sheets. (Klinkert says for stowing cable or sails, ropes, &c.).

Cherok jegong.—Bow and stern-lockers.

Chupu-chupu (*tiang*).—Mast-steps and partners.

Dandan.—Projecting or bow or stern galleries, as in many old and some modern sailing-vessels.

Dap'ras or *daperas.*—A rope "fender" for protecting the side of a ship.

Daun dayong.—Lit. "Oar-leaf;" *i.e.*, oar-blade.

Daun pengayuh.—Paddle-blade.

Dayong.—Oar.

Gading-gading.—The ribs (lit. ivories or elephant-tusks) of a built-up boat.

Gai p'lang jib.—Bowsprit-stays.

Gaing.—Klinkert says: "Beak-like piece formed by the tapering of both stem and stern of a ship above the keel."

Gandar sauh.—Shank of anchor.

Gelemat.—(Horizontal) forked strengthening-piece inside stem (of a river-boat or "Ketiap" only).

Gula (also *algula*).—Grommets or oarloops (made of rattan, for oars).

Jamban.—The "jakes." (Dinding jamban, the side of the "Jakes") *v. Jerambah.*

Jaring-jaring.—Lit. nettings or network, *i.e.*, the gratings of the flooring of a sampan, &c.)

Jempu-jempu.—Ensign-staff step.

Jongor.—Jib-boom (spar on end of bow-sprit).

Jerambah.—The open-work floor of a dandan or out-rigged stern gallery, consisting of narrow fore-and-aft battens, with open spaces between them, and used as a "Jakes," &c. (Klinkert says, place where plates are washed and people bathe, the (cook's) gallery on board, &c.).

Jerambah.—Out-rigged bow gallery.

Jerubong.—Klinkert says: "Projecting roof above the deck, made by covering in with matting the cargo which cannot otherwise be stowed."

Kajang serong.—Lit. cross-kajang or awning.

Kamar (or *bilek*).—A cabin (fr. Port. Kamar).

Kamudi.—Rudder. 1. *k. sepak* or the kicking rudder (the native steering-paddle). 2. *k. chawat*, the "close-shipped" or European rudder (lit. "loin-cloth" rudder, because it is fitted to the stern-post).

Kandar (*dayong*).—*v. gandar* (or *batang*).

Kapi.—A double sheave-block.

K'ladau sauh (or *keladau*).—Cable-bits, extending across bows, on which cable is wound.

Kelikir.—Robbins for bending sail to yard.

Kelikir (*dayong*).—Big rattan loop lashed to sangga (*q.v.*), for carrying oars, like European fisherman's lumber iron.

Ketam Kamudi.—Lit. Rudder crab. An ornamental plank taking rudder upright in the sea-canoe (*kolek*) only.

Kota mara.—Tranverse deck bulkheads at stem and stern.

Kuku.—Lit. "Claw" or "talon"—anchor fluke.

Kurong.—Deck-house. K. bajau, the deck house of a pirate (gubang laut), which consisted of two separate fore and aft shelters facing each other at the stern.

Lantei.—Flooring (of a sampan, &c.); frequently a wooden grating or grid.

Layar, or *layer.*—A sail. (*a*) native, of the leaf of the screw-palm, or the "kadut," &c.; called *l. batang* (*b*) foreign: *e.g.*, the cloth sail.

——— *Puchok jala.*—Lit. "peak of casing-net" sail; *i.e.*, what we should call "shoulder-of-mutton" sail.

——— *Bara gawir suai* (? extra sail "between the masts").

——— *Bara gawir suai.*—Staysail.

——— *Bara gusi.*—Main-sail.

Layar, Gap topsier.—Gaff-topsail, or topsail.

——— *Trengkit.*—Foresail.

——— *Trengkit gedeling.*—Fore topsail.

——— *Trengkit topsier.*—Fore-topsail (over gaff ?)

Leper leper.—Flat top of gunwale.

Liang kumbang.—Lit. "Borer-bee holes," limber oles, *i.e.*, spaces left underneath the ribs for the 'ater to pass by (to reach the bailing-well).

Linggi.—Stem- and stern-pieces of some Malay shing-boats.

Linggi or *kepala 'luan.*—Stempiece (*kepala 'luan* -bow-head). [Linggi also means stern-piece, but)r this the corresponding synonym is *kepala buritan*, r stern-head.]

Linggisan (*dayong*) or *linggis.*—False gunwale-iece, taking the grommets.

Lunas.—Keel or keelson (European).

Magun.—By some said (rather vaguely) to be a small hut above the kajang"; by others, "a small helter formed by an additional kajang in the stern (at he back of the main awning).

Mata kakap.—Lit. "scout-hole," or more lit. scout's eye"; *i.e.*, the plughole.

Mata ketam—Lit. "crab's eyes"; *v.* angkul-ngkul. (These mata ketam are short sticks with knobs n them, thus resembling crab's eyes on stalks; they re fitted into the angkul-angkul).

Naga-naga.—Central fore-and-aft-piece let into eck between thwarts, over bailing-well; *v.* also aga-naga, *infra.*

Naga-naga.—Lit. the "Dragon"; bottom floor-oard or stringer; horizontal fore-and-aft timber nailed o the keel, along the inside of the boat; *v.* also aga-naga, *supra.*

Pakau.—(1) Strengthening piece, as in case of akau rubing; (2) cross-piece, like the bar of a ucket or bailer, which is used as a handle for making ope fast to, &c.

Pakau kajang.—Split cane. Strengthening piece or edge of awning or kajang.

Paku chabang 'luan.—Metal fastenings holding trakes to bow rib. (Paku=nail). Lit. "nails of ow-fork."

Paku gading-gading.—Metal fastenings holding trakes to rib abreast mast. (Lit. "rib-nails.")

Pangger.—The cross timbers taking the flooring of sampan, &c.

Pantok.—Short weather-boards on the quarters in river boat or ketiap.

Papan guntong or *guntong* (only)—Top-strake.

Papan kamudi.—Steersman's out-rigged seat.

Papan lupi (or *lopi*).—Stern-sheet floor-piece for teersman (in the "kolek" or sea-canoe).

Papan tembatu.—Fore-and-aft battens of out-rigged allery.

Papan ketiak.—Lit. "arm-pit planks," *i.e.*, hori-ontal out-rigged wash-boards on each bow.

Papan lapek sauh.—Bow-sheets (on which anchor s stowed).

Pasak tuli.—Lit. "deaf"-pegs, *i.e.*, wooden pegs naking fast ends of strakes to stem.

Pelkah.—The hatch.

Pemetar or *pemutar* (also *tangan*) *kamudi.*—The tiller [lit. the turning-piece or rudder-arm (tangan)].

Penchachi.—A pin or lever (short spar), used only to help in rolling up the leaf sail, which is much harder to roll than a sail of cloth upon the boom, whether for reefing or furling.

Pendua apit lempang.—Middle (lit. 2nd) strake.

Pengayuh.—Paddle.

Pengapit Rubing.—Lowest slat (or split cane), made fast to gunwale and ribs, to hold in place the bottom of the "rubing" (*q.v.*).

Perambut takal changking.—Stropping of peak-halyard block.

Perapatan.—The jointure or joining-places of the strakes. Probably also originally a wooden caulking-piece, such as is well-known elsewhere. Klinkert does not mention this, but gives *perapat*—a peg upon which, or hole in which, the oar-handles are stuck (?).

Peruan.—Yards, *i.e.*, andang-andang (*q.v.*)

Perimpin.—The luff-rope (rope edging of foreport or "luff" of the sail).

Petak.—The hold.

Petak ikan.—The fish-hold.

Pisang-pisang.—Lit. the plaintain or banana, *i.e.*, the galver-strake or rubbing-strake.

'*Pit.*—Described as a spar or timber above the main-sail, apparently another name for the gaff or yard (possibly a confusion with English peak).

Rubing.—False gunwale, or wash-strake, made of palm-leaf and fixed on to the gunwale of Malay fishing-boats, &c.

Sampan slit.—A dug-out with in-board wash-strake.

Sangga (*galah*).—Solid forked lumber-piece for carrying quanting-poles, &c.

Sauh.—Anchor.

Sengkar.—A thwart.

Sengkar B'lakang.—Stern-sheet thwart.

Sengkar Timba ruang.—Bailing-well thwarts.

Sengkar tiang (or *tiyang*).—The mast thwart.

Senta.—According to Klinkert, the fore and aft timbers on which the deck timbers ("deck baulks") come to be laid.

Senta (or *rembat*).—Klinkert says rimbat, the false gunwale-piece taking the grommet (linggisan *q.v.*, but *v. senta supra*).

Serempu.—Dug out keelpiece, previous to building upon, or, more strictly, "keel and bottom-piece."

Siar (or *sier*).—Sail (Eng. ?).

Siku-siku.—The "knees," according to Klinkert. Lit. it means the "elbows."

S'kat Kamudi.—Aft, thwart.

S'kat 'luan.—The bow thwart.

Subang babi.—Lit. pig's ear-rings (from its shape); *i.e.*, false stem-taking ends of false gunwale (rubing).

Sulor-bayong.—Ornamental wooden scroll finial in stern sheets of sea-canoe (kolek).

Tajok.—Native forked rests (or crutches) for supporting the ends of the Malay awning or kajang.

Tajok lelei (*v. supra*).—Elongated rib with knee at stern, taking the end of the "rubing" or surf-board.

Takal.—A single sheave block.

Tali anak.—The lashing which holds cable to shank.

—— *Anjar.*—Peak halyard (standing part).

—— *anggo'.*—Lit., nodding or pitching rope—the name given to the bobstay of the jongor (jib-boom, *q.v.*).

—— *bara gai.*—"Rope used with boom of stern-mast." Main tack.

—— *bubutan.*—Runners or running back-stays.

—— *bustai*—(Eng.) "Bob-stay."

—— *changking.*—Peak halyard (hauling part).

—— *dugang.*—Man-rope, enabling crew to lean out-board to windward when carrying press of sail.

—— *k'lat.*—Sheet.

—— *Klendara.*—Yard parral, holding yard to mast.

—— *Labrang.*—Synonym for timberang; shroud, or main halyard.

—— *lalei.*—"Vang," controlling the end of the yard.

—— *prahu.*—Lit. boat rope (the "painter").

—— *Sauh.*—The cable (lit. anchor rope).

—— *Temberang* (or Témbérang).—Shrouds; main-rigging.

—— *Trengkit gai.*—Rope used with boom of fore-mast (fore tack).

Teletei.—The slats of the rubing (wash or surf-board).

Tembatu.—Fore and aft battens of out-rigged bow gallery.

Tembuku.—Flat wooden block in which the thole is stepped.

Tiang (or *tiyang*) *agong.*—The main-mast.

Tiang (or *tiyang*) *gapil.*—The mizzen.

Tiang kamudi (or *tiyang k.*).—The rudder-upright, holding by a grommet the rudder head. This is in craft where the rudder is used on the quarter, generally on the lee side.

Tiang (or *tiyang*) *tupang.*—The foremast. Klinkert says this mast (the foremast) is called *T. tupang* from the fact that it stands so close to the crutch (*tupang*) on which the awning (*kajang*) rests.

Timba.—Bailing bucket or "bailer."

Timba ruang (or *ruwang*).—The bailing-well.

Tenda.—Short weather-boards on the quarters in a Nadir.

Tolak bara.—Ballast (also talas).

Tombak sayang.—Lit. "Hugging lance" (or "shaft"). Sparbowline fitting into a cringle in the luff.

Topang kajang.—Awning crutch (when made in two pieces, taking the ends of the awning or uajang).

Tul.—(Eng.) thowl or thole (Dutch), "dol."

Tupei-tupei.—A "cleat" [piece of wood fastened to a mast, thwart, or gunwale, for belaying ropes: distinct from belaying-pins, which go through a thwart or gunwale].

Ular-ular.—Lit., the "snake" or "serpent." (1) a "State" or "Royal" pendant or streamer. (2) See the scroll-work at the side of (out-rigged) galleries.

Ulu pengayuh.—Paddle-handle.

Ulu (*dayong*)—The "loom" of an oar (lit., oar-head, or hilt).

DISCUSSION.

The CHAIRMAN said it was a matter of regret that Mr. Warington Smyth was not in the country to read the paper himself.

Professor A. C. HADDON F.R.S., said he had no special knowledge of the boats of the East, but everyone who had been to Hong-Kong or Singapore must have been much struck with the great variety of craft. Again, on going down the Malay Archipelago, one met with a very great variety of Malay boats. The Society was very fortunate in having a paper read before it by two such good observers as Mr. Warington Smyth and Mr. Skeat. In the museum at Cambridge there were the original models from which some of the illustrations accompanying the paper were obtained; and when the present paper was printed it would add very greatly to the value of their collection in Cambridge. Also, conversely, those who wished to study Malay boatbuilding would have to go to Cambridge in order to see the specimens. He was sorry he could add nothing of interest, but expressed the very great pleasure he felt, as an ethnologist, that the Society had published the paper, and that the work had fallen into such capable hands as those of the author.

Sir WILLIAM LEE-WARNER, K.C.S.I., said he regretted he was unable to throw any special light upon the subject. It appeared to him that the more civilised nations were apt to imagine that the half civilised people of the East were unequal to modern requirements. We were apt to regard their agriculture as very primitive and unsuitable, and, consequently, we were always sending reformers out to show the people there, for instance, that they had better plough the soil deeper. But in all those things it was generally found that there was method in their madness. It was evident that the Malays possessed strongly the instinct of self-preservation. In their "dug-outs" and boats of easy draught the Malays showed that they knew the way to escape from a man-o'-war or its boat. He could not help reflecting upon a period of history with which he was rather familiar, namely, the second Burmese war, in which we took Pegu, in Lord Dalhousie's time, and then the great difficulty that occurred was due to the banditti. Those banditti all had boats, and escaped by getting these boats very quickly ove shallows, and then running out and hiding themselves in the mango swamp, whilst the boats that were sent to catch them, never got near them. It was not until some months afterwards, when Lord Dalhousie found that land police were of no use against this banditti, that he adopted their methods, and, as it were, set a thief to catch a thief, instituting boat police. There was, undoubtedly, in all races in the world a strong instinct of self-preservation, and whenever such people started warfare against civilised nations, they were like our friends, the Boers, who, with their easy mobility, were better equipped for the task than those who came against them.

The **Chairman** said the paper was well worthy of consideration, because it was written by a gentleman who was a boat sailer, had studied boat sailing, and knew well the subject upon which he was writing. An English officer in Hong Kong, who had a racing boat, used to go racing there with Mr. Warington Smyth, and he knew from that officer's experience that Mr. Warington Smyth was a very competent hand. Whenever a man spoke or wrote upon a subject with which he was thoroughly familiar his remarks were always worth hearing, even though they might not be on the particular lines studied by some of his audience. He (the Chairman) knew something about Malay boats, because, before most of his audience could remember—in 1855—he was racing for three days down the Straits of Malacca, over the very waters where the boats described in the paper were found, against a very fast American cotton ship. He was then only a youngster, but he had not forgotten that the result of the race was very satisfactory, for on the third day, when the fugitive ship was overtaken, the drum and fife band played "Yankee Doodle." It was very interesting to watch the development of boats on various coasts. The Malay coastline was about 1,300 miles in length, and a boat was found on the Eastern side differing from that in the Western and sheltered waters. He would have liked to have heard Professor Haddon tell the meeting a bit of old world history as to the origin of the Malay skill. Whence did the Malay come, and whence did he obtain his knowledge of boat building? The features of Malays looked as if they were of the Kalmuck race. Geologists said that at one time Sumatra was joined to the Malay Peninsula, and that the people went on from there; that then certain geological alterations in course of time formed the Straits. At one time they appeared to have travelled as far as Madagascar and the African coast on the one, and to Celebes on the other, side. These were subjects of great interest, as were all subjects connected with the history of the world, and how it was formed. The Malays certainly developed an extraordinary skill in the handling of small boats, and they were essentially a courageous and fighting race. Everyone had noticed that in the comparatively short life—as the history of nations went—of Japan, that nation had risen from mere boat-sailers, to become seamen on some of the biggest ships, and ships of the highest class. When he first went to Japan, half a century ago, the Japanese were kept by their rulers from employing vessels of size adapted to ocean navigation and were restricted to using small boats for coast and fishing purposes. Most people scouted the idea that Japanese could employ or manage such large vessels as would enable them to take long foreign voyages. But now these people managed the finest battle ships which the world had ever seen. They possessed the highest qualities as seamen, and the highest powers which could be exhibited by any naval race. In the Chino-Japanese war, the Japanese men froze to death at the post of honour, and no higher praise could be accorded to any race than to the Japanese, who were now, he was glad to say, our Allies. Wherever one went there was evidence that the boats were adapted to the particular conditions of wind and weather, and harbours of that particular part of the world. The coasts of the United Kingdom show a sufficient number of diverse types to afford an interesting study. The craft employed by the fishermen in the Hebrides were of one type, the Yorkshire coble was another. The Thames shrimpers used Bawley boats specially suited to their needs. The Portsmouth boatmen had in a long series of years devoloped a form that suits them, and passing over many intermediate types the fishermen from the east side of the Start have boats 22 feet by 7 that they launch even in heavy weather, and attend their crab pots off the Start Rocks, and in the swirling tide and seas of the Skerries Bank. These are probably the best boats of their size in the world for work in disturbed water. The Penzance luggers are world renowned, and some, not even of the largest size, have travelled to New Zealand. Therefore, wherever one went, the different characters of boats, made to meet local circumstances, was a very interesting study. One could see that different types of tide, raising different types of sea disturbance, caused men to modify through a series of generations the common original type of hollowed-out tree, until the splendid present-day sea-going ships were produced. As he was only a landsman, it was not in his province to talk on that subject, particularly as some of his audience might know a good deal more about boats than he did. But, owing to the circumstances in which his early youth was spent, the subject of boat sailing had always been a craze with him, and therefore, he thought it would not altogether be wasting the time of his audience if he made a few remarks on what, to him, was a very interesting subject. He felt all present would accord a hearty vote of thanks to Mr. Warington Smyth for his admirable paper, and in that vote he would include Mr. Skeat.

The resolution was carried unanimously, and the meeting terminated.

Miscellaneous.

ECONOMIC CONDITIONS IN ITALY.

According to recent official statements, the economic situation in Italy is, on the whole, satisfactory. Agricultural methods, with a few exceptions, are improving in all the different departments. The importation of agricultural machinery has almost quadrupled in value in less than ten years, in spite of the development of native manufactories. Fifty factories of chemical fertilisers produce some 450,000,000 pounds, valued at £1,160,000. Italian industries have not, as those of other countries, suffered from depression; one proof of their vitality is the fact that the importation of coal last year increased to nearly 5,000,000 tons, notwithstanding the exceptional rise in prices. That is an increase of 1,000,000 tons in four years. The movement to utilise the abundant hydraulic power in Italy merits special attention. In January, 1899, it was estimated that the water-power already utilised represented a force of 300,000 horse-power. Since then numerous and very large hydraulic and hydro-electric installations have been made, and others are projected—among them the diverting of the Volturno, which would give 20,000 to 30,000 horse-power for the electric traction between Rome and Naples. Italy may be said to possess the largest installations in Europe for the utilisation of hydraulic forces. The yield of the mines and metallurgical establishments, which in 1897 was valued respectively at £2,470,000 and £8,800,000, has increased to £3,280,000 and to £12,160,000 respectively. In chemical industries, the development has been more rapid still; the value of the products in 1897 was £1,430,000; in 1900 their value was £2,430,000. The production of silk textiles is continually increasing. Up to 1890 the imports of silks exceeded the exports; since 1891, the situation has completely changed. In 1894 the excess of imports was 141 metric tons; in 1900 it was 746 metric tons. Great progress has also been made in the manufacture of cotton yarn and textiles; the number of spindles has more than doubled (from 900,000 to 2,000,000) in the last twenty years, while the number of looms has almost quadrupled (13,500 to 60,000). The value of the products has increased from £2,440,000 to £11,600,000. The number of workmen employed has nearly trebled (53,000 to 134,000). During the three years 1895-1897, the average value of machinery imported was £1,540,000; in 1900 it was valued at £3,165,000. The manufacture of sugar has assumed extraordinary proportions, and already suffices for two-thirds of the national consumption. The amount produced is valued at £772,000. The development of the merchant marine is also noticeable. In 1896, the movement in the Italian ports was represented by 6,892,000 tons under the national flag, and 7,700,000 tons under foreign flags. In 1900, there were 20,000,000 tons under the Italian flag, and 8,000,000 tons only under foreign flags.

Correspondence.

THE ORIGIN AND HISTORY OF CARRIAGES.

Mr. GEORGE A. THRUPP writes:—The paper by Mr. Albert Chancellor on the "Origin of Carriages" has been read to me, and I wish to bear my testimony to the admirable manner in which he has discharged his task. I wish to add, that the chariot of Lord Darnley, in the South Kensington Museum, is the earliest example extant of English coach-building. It was made for John Bligh, of Rathmore, in Ireland, created Lord Darnley in 1723. It is undoubtedly a type of the light chariots described by Dean Swift, and I consider that it was built prior to 1700, as the shape of the body, and the entire under-carriage, are certainly of the Louis Quatorze period.

The remarks of Sir George Birdwood on the solid wheels of wood and stone used in Hindostan and other parts of the world, merit the attention of every historian of coach-building.

MEETINGS OF THE SOCIETY.

COLONIAL SECTION.

Thursday afternoon, 4.30 o'clock:—

MAY 29.—"Western Australia: its Progress and Resources." By the HON. H. W. VENN. J. PARKER SMITH, M.P., will preside.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, MAY 20...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Carl Pearson, "The Laws of Heredity, with Special Reference to Man." (Lecture I.)

Pathological, 20, Hanover-square, W., 8½ p.m. Annual Meeting,

Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 21—Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. W. H. Dines and Capt. D. Wilson-Barker, "Report on the Wind Force Experiments on H.M.S. *Worcester* and at Stoneness Lighthouse." 2. Mr. Hugh Robert Mill, "The Cornish Dust Fall of January, 1902."

Microscopical, 20, Hanover-square, W., 8 p.m. Exhibition of "Freshwater Entomostraca," by D. J. Scourfield.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Annual Meeting.

Archæological Association, 32, Sackville-st. W., 8 p.m.

THURSDAY, MAY 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Spielmann, "Contemporary British Sculpture." (Lecture I.)

Electrical Engineers (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 8 p.m. Annual Meeting.

FRIDAY, MAY 23...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Rev. Canon Ainger, "The Ethical Element in Shakespeare."

Clinical, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MAY 24...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Brander Matthews, "The Development of the English Drama." (Lecture I.) The Art of the Dramatist.

Linnean, Burlington-house, W., 3 p.m. Annual Meeting.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT WEEK.

Tuesday, May 27, 8 p.m. (Applied Art Section.) Miss May Morris, "Pageantry and the Masque."

Thursday, May 29, 4.30 p.m. (Colonial Section.) The Hon. H. W. Venn, "Western Australia: its Progress and Resources."

Further details of the Society's meetings will be found at the end of this number.

CONVERSAZIONE.

The Society's Conversazione will take place at the Royal Botanic Gardens, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 p.m.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards will be forwarded in due course. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

Proceedings of the Society.

COLONIAL SECTION.

Tuesday afternoon, March 25th; The Right Hon. Sir Charles Wentworth Dilke, Bart., M.P., in the chair.

The paper read was—

THE SPHERE OF STATE ACTIVITY IN AUSTRALIA.

By the Hon. Sir John Alexander Cockburn, K.C.M.G., M.D.

Of all the controversies which have arisen among political economists, none has been keener or more prolonged than that waged over the imaginary boundary within which theorists have attempted to confine the exercise of the functions of Government.

Dire calamities have been predicted as the inevitable penalty of transgression beyond the limits of the prescribed circle, but such forebodings have been falsified and academic restraints pushed aside as lightly as cobwebs whenever they have crossed the path of the men of action on whom the progress of the world depends.

In stationary ages, hard and fast lines might with advantage be laid down and maintained for prolonged periods, but under the wings of the modern movement, when all is in transition, anything approaching rigidity becomes rapidly translated into arrested development.

Doubtless the lake dwellers of the Stone Age were conscious of the attainment of finality and perfection, but since the dry bones of remote stationary epochs were roused to life and vigour, elasticity and mobility have been the index of capacity for development, and efforts to arrest the cycle of evolution must be for ever vain until the age of ossification again sets in.

In a young country especially, all attempts to place an unyielding ring round the rapidly growing social organism, are foredoomed to failure. The Australasian Colonies came into active existence at a time when the *laissez-faire* tide ran high, and had such a regime proved practicable, nothing would have better suited the enterprising individualism of the settlers than to have accepted the narrow view of State action so strenuously promulgated by the political writers of that period, and to have taken comfort for any qualms as to remissness in the discharge of civic duties from the once fashionable phrase that the summit of public good is best achieved by each pursuing his own selfish interests.

The chief characteristic of Australians is alertness and power of adaptation, and the impossibility of carrying old doctrines into new territory was soon discovered.

The capacity to accomplish any great undertaking was found to belong only to collective and organised effort in the hands of the State. This conclusion was first made manifest in the matter of railway construction. In New South Wales, between 1846 and 1854, unsuccessful attempts were made to construct railways by means of private enterprise; but the Government had to step in and complete the work, and similar results ensued elsewhere.

The ownership of State railways in Australia is, therefore, due, not to theory, but to a common-sense acceptance of actual conditions. Subsequent experience has firmly established the public advantage of State-owned railways. Although the purchase money would wipe out all their indebtedness, Australians would as soon think of selling their streets as of allowing their main arteries of commerce to pass into private hands. The railways are managed, not only with the view of yielding profit, but in order to extend settlement and to encourage productiou. Artificial manures and other necessities for agriculture are afforded special freight advantages, New Zealand carries lime free for this purpose, the carriage of home produce is arranged on the lowest basis, and it is regarded as no sin to grant some preference as compared with foreign goods. On the contrary, a patriotic bias in the schedule of rates seems the most natural thing in the world. Certainly the opposite practice obtaining in this country would be regarded as intolerable in Australasia.

In order to guard against the possibility of the intrusion of undue political influence, steps were taken about 20 years ago, in most of the Colonies, to vest the management of the railways in the hands of Commissioners, usually three, who were practically independent of the Government. The dual authority thus created was found to be not in all cases satisfactory, and in Victoria, Queensland, and South Australia, single Commissioners in closer touch with the Government have been substituted. New Zealand in 1895 reverted to the system of Ministerial control, and the Minister for Railways reported in September, 1901, that the concessions in freight, since the resumption of control of the Government, amounted to £420,000, including reductions in the rates for live stock, chaff, butter, cheese, agricultural produce, and manures, and that a 3 per cent. interest on capital having been secured, further reductions for wool and for small lots of dairy produce, butter, poultry, eggs, bacon, cheese, and manures, would be made; 56 lbs. of fruit and vegetables, locally grown and packed, are carried any distance on the New Zealand railways for sixpence. Animals for breeding purposes are returned free, and those exhibited at shows are, if unsold, sent back free, and half the forward carriage returned. In New South Wales, flour, grain, and potatoes, in six ton lots, are carried 500 miles for 14s. per ton, and hay, straw, and chaff, 300 miles for 9s. 9d.; 400 miles for 11s. 2d., and 500 miles for 12s. 6d. per ton.

Telegraphs and telephones naturally followed the precedent of railways and are now entirely the property of the public. These, together with the postal services, were on March 1st of last year taken over from the Australian States by the Commonwealth Government.

It goes without saying that the practice, universal with one stupendous exception, of utilizing the customs tariff to the advantage of home industries has been definitely adopted. Experience in Australia has over and over again demonstrated that wisely imposed duties by fostering production frequently lead to a reduction in price, and to the supply of an article better suited to the local requirement. It may, however, be noted in passing that the Liberals are, as a rule, protectionists, and the Conservatives free traders.

A sentiment in favour of some degree of reciprocity in Intra-Imperial trade is rapidly gaining ground, and is espoused by many free traders. Indeed, the only practicable path to general free trade, should it ever be attainable, would seem to lie through reciprocity. It is probable that any concession in this direction made by the Mother Country would meet with a ready response.

The encouragement of production by means of bonus is also of every day occurrence. The butter industry is a notable instance of the permanent success thus attained, and the Commonwealth is making provision for the establishment of new industries by this method.

The same desire to further the efforts of producers, has led to the establishment of State banks, which provide the necessary capital to farmers and graziers at the lowest rates of interest. This step was vehemently opposed as a serious infringement of ancient dogma, but is now accepted with profound satisfaction. All classes share in the benefit when the basal industry of agriculture is prosperous. The public revenue is buoyant, the doctor receives his fees, the parson his stipend, and the storekeeper makes few bad debts. It is not maintained that the general rate of interest has been affected by these State lending agencies, but the ocean level of interest, previously inaccessible, has been brought to the farmer's door. The incidental charges for preparation of the necessary mortgage are trivial; and provision is made for redemption by periodical payments, so that at the end of a term ranging up to 21 years the settler finds himself free from debt. Up to March 31st, 1901, New Zealand had advanced 8,901 loans to settlers, amounting to £2,679,520. The working of the Acts in the several colonies has been attended with great success; there are practically neither bad debts nor arrears. In South Australia the loans are provided for by the issue, from time to time as required, of mortgage bonds guaranteed by the Government, and bearing interest at 3½ per cent.

The chief argument employed by the opponents of the State Advances Acts was that they were hostile to private enterprise; the reply to this was that any measure which assured to the agriculturist the due reward for his labour, which brought hope into his life by removing from his neck a millstone of debt, in reality strengthened his sinews and lightened his toil and afforded the most efficient encouragement to the most deserving of all private enterprises.

Coincident with this infusion of the life blood of cheap money steps were taken by the Governments to still further assist the enterprise of the farmer by enabling him to market his produce to the best advantage. Produce is received by the departments of agriculture, prepared for shipment, certified as to quality, and graded. Small parcels from a number of producers are grouped together in one consignment and shipped at lowest rates to the world's markets.

In addition to these facilities the Government of South Australia undertakes, if so desired, to act as agent in London for the consignor, and to arrange for the sale of the produce, so that a farmer who has no representative at the port of destination, but is desirous of ascertaining whether a profitable trade can be established in any class of perishable produce, has only to send the goods to the depôt, and await the arrival of a cheque when the account sales come to hand. Nor is the consignor kept out of pocket during this interval, an advance amounting to three-fifths of the value of the produce at 5 per cent. interest is at his disposal. So beneficial to the agriculturist have the operations of the depôt proved, that a Minister of Agriculture, who is also a practical farmer, estimated that land within easy access to the depôt, had, by this agency, been increased in value to the extent of 10s. an acre. Some of the States, in order to facilitate trade, have announced that a buyer in any part of the world can secure the quality of goods desired by arranging for the purchase to be subject to examination before shipment by the official experts. "Orion" wine shipped through the South Australian department is analysed and examined in bulk, and, if found to be both sound and pure, is sent forward with a certificate to this effect, which is recorded on the label of the bottles in which it is retailed.

The dairy industry was in its early stages fostered in Victoria and South Australia by an export bonus and practical demonstration of the best methods of working were given by means of travelling dairies. With the view of improving the breed of dairy cattle, State bulls have been stationed in many of the dairy districts in South Australia. In New Zealand, animals for breeding purposes are conveyed to agricultural shows on the railways at very low rates.

No effort is spared to minimise and eradicate bovine tuberculosis. Herds are examined and tested in South Australia and elsewhere with tuberculin, and diseased dairy cattle are destroyed. A rigorous inspection is made of all meat for export and diseased carcases are rejected. Stringent measures are also adopted to prevent human infection. In Sydney, recently, sixteen individuals were charged before a magistrate with expectorating on the footpath and were fined 10s. each, or, in default, three days' imprisonment.

The mineral resources of the State are also developed with the same watchful care. Cyanide works have been established in various centres for treating ore supplied by miners in the neighbourhood, and State smelters for copper ore were started some time ago at Port Augusta in South Australia.

The Governments of Victoria and New Zealand are opening up mines for the supply of coal to the State railways.

A system of old age pensions was first introduced by New Zealand, and is rapidly extending in the Australian States. The age at which a pension may be claimed is that of 65 years. In March, 1901, 12,405 pensions, amounting to £211,965, were in force in New Zealand. As a sign of the times power has been taken under the Commonwealth Act to establish such pensions throughout the whole of Australia. From every point of view the proper care of the aged and infirm may be regarded as one of the most imperative of public duties, being in accordance with the spirit of the Divine Law which indicates reverence for age as a condition of enduring national life.

In South Australia and New Zealand there are Public Trustees who undertake the administration of estates entrusted to them, thus relieving testators from the necessity of thrusting upon friends a task which is frequently found to be onerous, invidious, and thankless. Widows, minors, and beneficiaries, can thus be spared the trouble caused by death or resignation of trustees or executors, and the possibility of fraud, or of speculative investments of trust funds is obviated. The Public Trustee in New Zealand also acts, if so desired, as agent or attorney.

In the establishment of Industrial Arbitration Courts, New Zealand and South Australia have been the pioneers, and to the former belongs the honour of being the first country to bring a workable Act into existence. The Act recently passed in New South Wales makes disastrous duels in the industrial world as illegal as that barbarous method of settling individual disputes. This Act, which was introduced by the Hon. B. R. Wise, the Attorney-General of the State, erects a tribunal of three, consisting of a Judge of the Supreme Court, with one representative nominated by the employers, and another nominated by the *employés*. This Court has jurisdiction in the case of any industrial dispute or of any industrial matter referred to it. The Court may, on award, prescribe a minimum wage in any trade, and may direct that unionists shall be employed in preference to others; it may also declare any custom, rule, or practice, to be the common rule of an industry. Whoever, before the lapse of a reasonable time for the reference of a dispute to the Court, or pending the proceedings of the court, declares either a lock-out or a strike, or instigates thereto, is guilty of a misdemeanour, and is liable to a fine of £2,000 or two months' imprisonment. Provision is made for the registration of unions, and a certificate of registration carries with it incorporation.

The Right Hon. C. C. Kingston, Commonwealth Minister for Trades and Customs, drafted, when Attorney-General of South Australia, the first Bill dealing with the settlement of industrial disputes which was introduced into an Australian Legislature, and at the Federal Convention, held in Sydney in 1891, sought to bring such legislation within the scope of the Federal Bill. This was afterwards accomplished in 1898 at the subsequent popularly elected convention, when, on the motion of Mr. Higgins, the item "Conciliation and Arbitration for the prevention and settlement of industrial disputes extending beyond the limits of any one State" was inserted among the Federal Powers.

Acts for the regulation of shops and factories and for early closing have become matters of course. A bold and successful attempt to check sweating has been made by the establishment of special Boards empowered to fix a minimum wage in various trades. In Victoria, among the special Boards are included those empowered to deal with wages in the following trades:—Bread, boot, clothing, furniture, shirt, underclothing, butchers, brick, carriage, cigar, confectioners, coopers, engravers, fellmongers, jam, jewellers, milled broom, pastry cooks, plate glass, printers, pottery, saddlery, stone cutters, tanners, tinsmiths, wood workers, and woollen. The Boards consist of not less than four nor more than ten members, half being representatives of employers and half of *employés*, together with a chairman not being one of themselves, elected by the members or appointed by the Governor in Council. The Boards may fix both wages and piece work rates for persons employed either inside factories or outside in certain trades. Under the Board system the following increases in weekly wages have been made:—By the Boot Board, 4s. 9d.; by the Bread Board, 11s. 7d.; by the Clothing Board, 2s. 6d.: By the Shirt-making Board, 3d.; by the Underclothing Board, 1s. 4d.

The Chief Inspector of Factories for Victoria, in his report for the year 1900, states that after some years' experience, he is convinced that the fair employer has little if anything to fear from the determination of the special Boards. There are many factories into which it is seldom, if ever, necessary for the inspector to go, as the proprietors take a pride in keeping them in a cleanly condition and always pay the minimum wage and often a great deal more. The operation of the Acts appears to compel the sweater and unfair manufacturer and shopkeeper to carry on his business somewhat on the lines of the fair employer. If by this means good factories with proper sanitary provision, reasonable hours of labour and a fair wage can be obtained for the workers of the State, it will generally be admitted that the restrictions imposed by the Factories and Shops' Acts are justified and work for the good of the employers, workers, and of the State generally.

From these and numerous other examples of encouragement on the one hand and wholesome regulation on the other, it may be gathered that democracy in Australasia has nothing in common with laxity. A strange reversal seems to be taking place in party aims. The Liberal platform tends towards the extension of law and order in many new directions, whereas the old cries of freedom of contract and the liberty of the subject are now most frequently heard in Conservative quarters. Australian experience seems almost to indicate that it is licence rather than liberty which flourishes in the soil of *laissez-faire*.

Not many years ago a Liberal Government was accused of a desire to re-introduce the curfew bell, because they were opposed to allowing children of tender years to hawk newspapers and matches in the streets after a certain hour at night. The mere fact that in the trend of modern movements something analogous to old time traditions may be traced, does not necessarily carry with it condemnation. Many ancient customs were eminently salutary and were based on natural laws. Physicians are now making the discovery that several mediæval remedies, such as red light in the treatment of small-pox, and glandular extracts as medicines are not altogether devoid of the virtues formerly ascribed to them.

The etymological sense of the word *reform*, not infrequently indicates its true significance; it implies a harking back to old and sound principles. The injunction contained in the lines—" Stand ye in the ways and see and ask for the old paths, where is the good way, and walk therein "—breathes the true spirit of reform which desires to prove all things, and to hold fast that which is good.

The demolition of all social bonds save the cash nexus is merely a temporary stage. Ties of human relationship and mutual obligation will again assert themselves, but those of the future will be fraternal in place of patriarchal.

Old time establishments proved incapable of meeting the growing requirements of industry and commerce, and it was necessary to raze them to the ground; not in order that the land should lie perpetually waste, but that institutions fairer, more commodious, and better adapted to the new order should take their place.

In Australia, the constructive age has again commenced, and, with the alertness and mobility engendered by bright skies and comparative freedom from the friction of vested interests, the Britains of the southern seas are intent upon solving the problems of the future.

Regulations and restrictions which, under Autocratic rule, were regarded as tyranny, and resented as such, become, under Democracy, a wholesome exercise of self restraint.

Between the excessive individualism which runs riot as anarchy, and the rigid regimentation contemplated by scientific socialism, there is a safe middle course for a practical people to pursue. The old watchwords have lost their meaning. Common-sense in every department of life is the order of the day, and Governments have to adapt themselves accordingly. Definitions of the sphere of State activity are in Australia impossible. Governments are regarded as the directors of a vast undertaking, in which every individual is a shareholder, and it is held to be their duty to do whatever may be necessary for the welfare and advancement of the community.

DISCUSSION.

The CHAIRMAN said that his friend Sir John Cockburn had dealt with State activity in Australia, and that Australian State activity was not only to some extent in contrast with a certain absence of State activity in Europe, but it was in marked contrast to the absence of State activity in the United States and in Canada. There was, in this respect, much more difference between Australia and the United States than between Australia and this country. The *laissez-faire* school continued to be much stronger in the United States than it was here, and those who had watched experiments in public activity in this country were aware that a very large number of things which were not done by the State or by the municipality in the United States or in Canada, and which were done by the State in Australia, were done in this country by municipalities acting under public law.

Many of the instances which Sir J. Cockburn gave of State activity in Australia might be paralleled by municipal activity here. This Parliament had allowed municipalities to undertake, although it would not undertake it itself for the whole State. He had not time to pursue the subject and go into the reasons which had caused Australia to develop along one set of lines, and Canada, following the United States, to develop—at present, at all events—along a very different set of lines. Sir J. Cockburn had been placed in a very good position personally to examine the matter for himself. He was a distinguished graduate of London University, and went out to Australia after he had gone through his educational life, with English ideas, and so was able to put them to the test of Australian experience. It would be unfortunate if the discussion were to take the turn of Protection *versus* Free Trade, because many who were present were partial heretics upon such subjects; not complete heretics like Sir John, inasmuch as they had what might be called a geographical conscience, they did not think that such matters were in themselves matters of right and wrong, but matters deserving of investigation in particular cases; and it did not in the least follow that because Protection might be defensible in South Australia or in Victoria it might be the best policy for this country. State activity did exist in the Australian colonies, quite apart from Protection and Free Trade. For instance, the bonus system upon export was neither Protection nor Free Trade; it was a separate matter like the granting of prizes. It might be right or wrong, wise or unwise, but it was not necessarily condemned by Free Trade principles, and might be accepted by a man who was a strong Free Trader. It was open, however, to a very great difficulty at the other end of the line. The bonus might start a new industry with great advantage to the people who initiated it, especially if they had the courage at the right moment to take away the protection which the bonus gave; but there was the other end of the scale, and the English farmer who made butter might naturally object to have the wealth of the Australian taxes brought to bear in unnaturally cheapening and sending butter to this country to compete with him. At the present moment there was the case of the sugar duties to show what happened at the other end of the line. The British consumer benefited by the efforts which the Continental nations had made to extend the manufacture of beet sugar in their countries, but the British producer in the British colonies, and the British manufacturer here of the partially made sugar complained of the unnatural efforts to reduce the price of the commodity in which they dealt. So that the bonus system could not be considered merely from the point of view of those who gave it to the industry at the moment of export, but consideration had to be given to what it was likely to lead to at the other end of the line. Generally with regard to State activity he was himself in sympathy with Sir J. Cockburn. He was in favour of State activity, and he thought all the movement of the age was in that direction—State or municipal activity—because there were certain matters that it was as well should be dealt with by populous cities. The average Australian colony was only, as regarded population, on the same scale as Glasgow and its suburbs, or Liverpool and its suburbs, and, therefore, it did not follow that what was State activity in Australia should not be municipal activity with ourselves. Sir J. Cockburn spoke of this being a constructive age in Australia, and that was certainly so. Australia was to be congratulated on the character of her legislation. Tasmania up to the present time had not followed the other States, and perhaps Sir Westby Perceval, who knew something about Tasmania, would say what was the cause of the difference. A most interesting example of State action in Australia concerned one of the last matters mentioned by the reader of the paper, viz., the attempt to check sweating in Victoria by the institution of Wages Boards, an example, as Sir John might have mentioned, that had been followed by South Australia while he was Agent-General for that colony. In the last Factory Act of South Australia the Wages Board provision had been introduced from the Victorian Act, although up to the present it had only been applied to three industries. The Act afforded means of dealing with the feebler industries, especially those in which very ill-paid labour, mostly women's, was employed, and it was the opinion of Mr. Deakin, as well as of others, who had watched the working of the new law, that it had been a considerable success. He noticed that a recent Commission which was appointed for the purpose, he thought, of pointing out difficulties in the way, and even recommending amendments in the Act, had blessed that which some thought it had come to curse, and the result was being imitated in the other colonies. Sir Thomas Fowell Buxton, who had had to leave the meeting, must have been deeply interested, when Governor of South Australia, in the working of the new Acts, and he should have been glad to hear what he might have said or what Sir J. Cockburn might say upon a point which was not alluded to in the paper, namely, how far the extension of the suffrage to all women as well as to all men had affected State activity in the colonies of New Zealand and South Australia, which were the most advanced in their legislation. Women's suffrage now prevailed also in Western Australia, and would probably in the course of this year be extended to the whole Commonwealth. It was undoubtedly the case that that great change had not produced many, perhaps not any, of the results that were expected from it. Woman suffrage was originally advocated in Australia, as it had been here, as a limited suffrage, but in no colony had it been carried in that form. When it came to the point, the moderates failed everywhere, and the Acts had all been Universal Suffrage Acts. In the towns of New Zealand there were now more women voters than men voters at the General Elections. He was inclined to think that the extension of the suffrage to women might have had some effect in the way of direct activity. [Sir J. Cockburn said that was so, especially in Factory Legislation.] Sir John had stated that in Australia, State activity was not a matter of theory, but of practice. That to some extent was so, but it would be idle to conceal the fact that the existence of a separate Labour Party in several of the colonies had greatly pushed forward the movement in the direction of State activity. In the Commonwealth Parliament at the present moment the Labour Party was not only powerful in the Senate, but in both Houses, and, while holding the balance in the Senate, it virtually held the balance in the House between the two regular parties in the State. That gave the Party the power of pushing forward their doctrines of State activity. The same thing had occurred in New South Wales and in New Zealand. The Labour Party were virtually the dominant party in the colony and had really ruled the colony for a great number of years past. Doctrines of State activity which were in this country preached by and existed in the heads of a minority only had, through the accidents of Australian politics, become the doctrines either of a majority as in New Zealand, or of a very powerful minority holding the balance between the parties in several other Australian colonies.

Sir Charles Dilke having vacated the chair, his place was taken by Sir WESTBY B. PERCEVAL,

Mr. J. M. MACLEAN said he had been greatly interested in Sir John Cockburn's description of the extended sphere of State activity in Australia, which constituted a triumph of Democratic Socialism. Many movements, however, in a similar direction had taken place of late years in this country, and Sir Charles Dilke had played a prominent and most useful part in them. State enterprise was by no means a new thing in England, as witness the immense development of the Post Office and its allied departments. In India, again, there existed a magnificent series of railways, designed and constructed by the State. What struck him chiefly in listening to the paper was, what a fortunate thing it was for Australia to be able to begin the world with what a certain distinguished statesman was fond of calling a "clean slate." Sir John Cockburn claimed for the Australians that their economic policy was based on new ideas, and that they had outgrown the policy of *laissez-faire*. But the policy of preferential tariffs, bounties for the protection of native industries, the prohibition of coloured labour, and so forth, was not new. It was the old system which was common for hundreds of years to all civilised States, and which England only shook off fifty years ago after a prolonged struggle in which Free Trade triumphed through sheer force of intellectual reasoning. A new commercial system was then introduced, which aimed at consulting the good of the general consumer, and not of the producer in any particular trade. England in this way obtained from all the world abundant supplies of cheap food for the masses of her people; she accepted with thankfulness supplies of butter and dead meat from Australia, grown by means of bounties and brought to the English market in bounty-supported ships, at rates which might seem unfair to the British farmer. In the same way she accepted bounty-grown sugar, which had been an immense boon for the English consumer. With such freedom of trade England had prospered, and she was not yet weary of it. It might be useful and necessary for the State in Australia to give large grants for the purpose of opening up a new country, but such action was not called for in a country like England. Similarly, in a thinly-populated country like Australia, which contained fewer inhabitants than Scotland, and not so large a proportion of old people, it was easy to deal with such a question as old age pensions; but here the problem is an infinitely more complex one, and we must move more slowly. But Australia had now taken the British empire in tow, and it was of advantage to learn from Sir John Cockburn's paper in what direction we were likely to be drawn by her.

Mr. G. COLLINS LEVEY, C.M.G., submitted that the railways in Australia were owned by the State, not as the result of any economic or political reason, but owing to the fact that money was too valuable in the early days of Australia to induce people to invest their capital in undertakings which under no circumstances were likely to pay more than 5 per cent. or 6 per cent. at the outside. The first railway, that from Sydney to Paramatta, was started by private enterprise, but it was found that it would not pay a rate of interest sufficient to induce people to go on with it. It was the same with the railway from Melbourne to Mount Alexander and other railways, which, started by private enterprise, very soon found it impossible to get the necessary capital. The State could borrow money at 5 per cent., whereas private individuals wanted 7 per cent. or 8 per cent. at the very least. As the Government were most desirous to open up the country by means of railways they thought the best thing was to float loans on the English market and make the lines themselves. It was almost too early to say that that policy had been quite successful. It had been so to a certain extent in some of the colonies, but others felt that the railways were paying rather badly, and the public at large had to dip their hands in their pockets to make up the deficiency. He thought the railway system in Queensland was a failure financially, but it had developed the country. In South Australia, New Zealand, and New South Wales, the system paid extremely well. The railways in Australia were State-owned at a time when State socialism was at a discount; they were not started to benefit the people, but because there would have been no railways if the

State had not taken them up. With reference to the Victorian Factory Act, there was no doubt that it had worked, on the whole, extremely well, although there had been cases of extreme hardship. The effect of the minimum wage was extremely cruel to old men and poor workers. Unless a man could earn the minimum wage he could get no employment at all, and it was very painful to see in the Melbourne newspapers complaints from men of this class that in consequence of this restriction they were absolutely destitute. In the same way the limitation of hours had worked rather harshly on some of the small employers. He would rather say that the Factory Act of Victoria and that of South Australia were at present on their trial. With all the other remarks made by Sir J. Cockburn he thoroughly agreed, and was sure that those who saw the result of the protective system introduced into Australia twenty-five years ago would say that it had been almost an unqualified success.

Sir WESTBY PERCEVAL, K.C.M.G., in proposing a vote of thanks to Sir John Cockburn, said, as he understood the matter, the reader of the paper was merely giving a history of what had occurred in the way of State activity in Australasia, and had not for a moment contended that the conditions here would enable all or even any of those reforms to be carried out in this country. The conditions were entirely different. It might be said that at least no harm had been done by the measures described in the paper. He (Sir Westby Perceval) had just returned from a visit to Australasia, after an absence of some years, and he was especially struck, in New Zealand in particular, with the immense progress that had been made by what he might call the small farmer. The prosperity of New Zealand was no doubt owing to the success of the small farmers, and the Government had a fair right to claim that the assistance that it had given to that class, in the direction Sir John Cockburn had indicated, had been a most important factor in the progress achieved.

The resolution of thanks to Sir John Cockburn, for his valuable paper, having been carried,

Sir JOHN COCKBURN, in reply, said he did not for a moment mean to imply that measures which had proved successful in Australia were necessarily adapted for universal consumption or under the conditions which obtained in this country. He tried to make it clear that the action of Australia had been empirical rather than governed by abstract or theoretical considerations. Possibly in this country it might be necessary to travel in the opposite direction. In Australia they were not afraid of notices warning them off the ground for fear of spring guns and mantraps. With regard to the remarks of Sir Charles Dilke, the right hon. baronet was an absolute master of the subject, and was able to deal with it in a masterly fashion. He was perfectly right in saying that municipalisation here was doing a gre deal of work that the State found it necessary to d in Australia, and just as Australia was strong i State activity so it was weak in municipalisation In his own State of South Australia there were no mun cipal trams and few municipal undertakings such were found in the great cities of the United Kingdom The people of South Australia had determined n to establish either State tramways or municip tramways in the City of Adelaide, and a Bill ha been passed giving a concession for an electric servic to a private company. It was hotly contested, an a referendum took place on the Bill, as was generall the case with important measures, and by a overwhelming majority it was decided that th concession was under the circumstances justifiable Perhaps he ought not to have said so much o Protection and Free Trade, and he was simply le by circumstances into doing so. It did not becom him to say whether Protection would be the righ thing here. That it was the right thing in Australi he was convinced. He was not prepared to say tha the work of destruction that Bright and Cobden an others performed in connection with the system o monopolies, patents, and tariffs was essentially wrong but he did think it would be a very good thing i some degree of reciprocity was shown between the mother country and her children, and he was quite sure that that would be devised, doctrinaires and Free Traders to the contrary. That a bonus worked a little hardship at the other end of the line he was quite prepared to admit, but the industries brought into existence by Australian bonuses did not inflict any injury upon the English farmer, because the Australian produce came to this country when the English produce was at an ebb. The only produce displaced was the produce from foreign countries, and Australians took some consolation from that fact. There was no reason whatever why there should not be some system by which the manufacturers and agriculturists in England and those of the Colonies might mutually benefit each other, and he believed that family relationship should be made manifest even in trade. With regard to women's franchise, and its influence on the sphere of State activity, the general predictions of evil had not been realised. On the contrary, the system had brought fresh interest into public life, and he was quite sure that in many of the questions with which he was dealing the woman's vote had proved a source of strength. Every woman was an administrator, every mother of a family was occupied with the subject of economy. She was a practical, experienced, reliable, and whole-hearted economist, and as such was not likely to be governed by abstract and theoretical ideas. If women saw a thing was right they did it. They had assisted in destroying the old ideas which prevented the extension of the sphere of State activity. What had been said with regard to old age pensions was perfectly true, that the number of people to be provided for here would be greater, ut then the wealth was greater also. What was rearded as the cardinal duty of men in the heyday f their strength with regard to looking after the aged nd infirm might not be of universal application, but t had the highest authority, and he questioned whether ny of the Acts passed had so much of the Divine anction as that had. It was applicable even to old, rosperous and wealthy countries, such as England. t had been done with advantage in Australia, and he full value had been realised of the word piety, hich was derived from the old Latin word, meaning espect for one's ancestors and for one's seniors. He elieved there was never a better instance of carrying he Fifth Commandment into effect than the Old Age Pension Acts in Australia. With regard to the lleged hardship of the Factory Act in Victoria on he aged and infirm, exemption had been made n such cases as Mr. Levey had mentioned, and ermits were issued by inspectors to anyone who, by reason of age or infirmity, was not able to give the service which should be given in return for the minimum wage. The Inspector of Factories, in his Report for 1900, said that permits had been given for ny old and infirm worker to work at less than the minimum wage, and suggested that evidence of hardship inflicted by the Act should be obtained from the workers themselves and not from mere hearsay statements. The reforms in Australia were not brought about easily. Those who were responsible for the recent legislation in Australia had to go through a perfect baptism of fire in their endeavours, and a minority, but still a large number, were of opinion that some of the Acts were wrong even in Australia; but they were open to the teaching of experience, and in any case in which the Acts had been established for a considerable number of years they were contented with them. He believed that shortly, when the Factory Acts had been in existence for a few years, the same feeling of content would prevail with regard to them as obtained with the advances made to settlers and in many other directions in which acknowledged success had been attained.

Miscellaneous.

YARN COUNTS.

The Silk Association of Great Britain and Ireland having received a communication from the Minister of Commerce of France, asking for their co-operation in securing a uniform system for the numbering of yarn counts, appointed an Expert Committee, consisting of Mr. Matthew Blair, Mr. Herbert Rowson, Mr. Sydney Thompson, Sir Thomas Wardle, and Mr. George Wigley. The following is the report of the Committee, approved by the Council May 7th, 1902:—

Your committee were appointed on February 26th, 1902, to report on an International System of Weights, Measures, and Yarn Counts, especially in view of the communications received from the Commission Permanente, located in Paris.

They have to report as follows:—

1. Count is the relationship of weight to measure. It always indicates a given length of thread in a given weight. Without this it has neither meaning nor use.

2. A uniform international count is, therefore, impossible, until there is a uniform system of weights and measures.

3. The metric system of weights and measures is so perfect, and has been accepted by so many countries, and by many scientific societies in our own country, that, most probably, sooner or later, it will be adopted by the British Government.

4. Until it has been so adopted, little good can be obtained by seeking to introduce in this country an international system of yarn counts.

5. The Silk Association should, therefore, in the meantime, press upon Government to introduce, and after two years' notice to make compulsory, the metric system of weights and measures.

6. A perfect international system of yarn counts should conform to two essential conditions:—

   (*a*.) It should be applicable to every kind of thread from the thickest yarn to the finest raw silk, whether single, twisted, knopped, looped, or eccentric, and should admit of no exceptions.

   (*b*.) It ought to show on the face of it the two factors out of which all count is compounded—namely, length relative to weight—these being the essential points required by spinners, merchants, and weavers in their various calculations.

7. The declarations of the Paris Conference do not conform to these conditions. The recommendation that raw and thrown silk should be exceptionally counted by the Italian skein of 450 metres is an unwise exception. It destroys the uniformity of an international count, and introduces a method of naming the count which differs from the metric system already accepted for all other classes of yarns. It would be quite as easy and convenient to name the count by the number of metres to the gramme, as by the number of grammes in 10,000 metres. The skein of 450 metres is purely experimental. It is only a test, made and then thrown aside, and might be retained as a sectional or local practice, but no silk is sold reeled in this manner, and it is an unsatisfactory system for an international count, which should be adapted to all classes of yarns. The Italian method has no recommendation, except that many people are at present using it, but this may be said of every count.

8. Presuming that the metric system of weights and measures were adopted, a perfect system of international counts could be formed by the observance of two principles:—

   (*a*.) The count of a yarn should be determined and named by the number of metres contained in a gramme.

(*b*.) This number should refer always to the completed thread, no matter of how many strands it may be formed.

9. The first principle (*a*) is Resolution No. 2 of the Paris Conference. They have not had the firmness to stand by it, but have admitted exceptions. It is adaptable to every thickness of yarn. The second principle (*b*) is absolutely necessary if the count is to cover every form of yarn. In no other way is it possible to express the count, that is, the length to the weight, in yarns which are composed of strands of different thicknesses—crêpe yarn, loop yarn, knop yarn, eccentric and fancy twists, as well as single yarn. Thrown silk has always been counted in this method. An international count should cover every class of yarn.

10. Hanks or skeins under such a system might be reeled to whatever length suited each trade. Since the introduction and now extensive use of the "Grant" system of reeling, the length of the skein is of little importance; the essential point is that the count clearly indicates the length relative to the weight.

11. It is unnecessary and impolitic to seek by any violent means to abolish the systems of counts or methods of reel which are now in use. So far as they serve local convenience they will be, and ought to be, preserved. But dealers, throwsters, and spinners should be urged to adopt the general use of the international count in all marking of their goods, in addition to any other count which they consider necessary or convenient. The usefulness of a uniform standard count, adapted to every country and every class of yarn, and expressed in such a way as to facilitate and simplify all manufacturing calculations, would in time secure its general acceptance.

The following explanatory memorandum on yarn counts was prepared by Mr. Matthew Blair, Chairman of the Committee:—

1. The terms "numerotage" and "titrage" are practically identical, and expressed by the English word "count." They all mean the length to the weight. They are not intended to shew the diameter of a thread. That is the province of "gauge," and can only be applied to a rigid substance like wire. Elastic materials are defined by length relative to weight.

2. It matters not whether the yarn be spun by a worm or by machinery, nor whether it be cylindrical, elliptical, or irregular along the line, or of what material it is formed. If it possesses length and weight it can be expressed in count.

3. To arrive at count, manifestly a yarn must be made. It must be in existence before it can be tested. The method of testing may vary with the class of yarn. It will generally be a skein of some fixed length, weighed, and the result ascertained; which result governs the bulk of the lot under consideration. Raw silk is not alone, as some seem to suppose, in being tested in this manner. M yarns are tested thus daily in the course of spinni to prove that the machinery is working correct and since the introduction of the "Grant reel" 5,000 to 10,000 yards, all yarns require to be tes by small skeins. But such test skeins, which will different with yarns of different thickness, while c venient for the operator, afford no suitable whereon to base an "International" count.

4. In whatever manner the testings may be ma the result should be declared in the "Internation count. It is quite as easy to call a silk No. 426, to call it 21 deniers. The former shows the length the weight—426 metres to 1 gramme—thus maki it in unison with the metric system of all other yar and rendering all manufacturing calculations ea The latter way is of little use except to a reeler. T manufacturer can make nothing of it until he calculated how many metres it gives to the gramme

5. The "International" count should become universal language, adapted to every class of fibre a every kind of manufacture, and understood in eve country. The calculations necessary for manufa turing could be made with facility, no matter ho many different classes of yarns, or from how ma countries, may be used in the same fabric.

PLATINUM IN NEW SOUTH WALES.

Although platinum is known to be more or le plentiful in New South Wales, the quantities present obtained are limited, the output in 1900 bein only 530 ounces, value £1,007; and the total quantit raised since the beginning of 1894 8,295 ounce value £12,432, the great difficulty being the scarcit of water in the districts in which the metal is found The metal is almost silver-white, and is met in native state alloyed with iron, iridium, osmium, an other rare metals. It usually occurs in grains o scales, sometimes in irregular lumps or nuggets, an rarely in crystals. A cubical crystal of platinum foun at Fifield, and now in the Sydney Geological Museum measures nearly three-sixteenths of an inch. It i infusible except at very high temperatures, is unacte upon by ordinary acids, but is soluble in hot nitro hydrochloric acid. Compact platinum does no amalgamate with mercury in the cold, so that it car easily be separated from gold by means of mercury The only other form in which platinum is found is that of an arsenide in the mineral sperrylite which occurs in minute cubes or cubo-octahedral crystals which have a tin white colour and black streak. The metal is largely used in chemical processes in the form of crucibles, dishes, spoons, spatulas, foil, and wire. Its indestructibility, its high melting point, and its insolubility in ordinary acids render it invaluable to the analytical or manufacturing chemist. The coefficient of expansion of platinum is nearly the same as that of glass, and hence the metal has been largely employed in the construction of incandescent ctric lamps for the purpose of connecting the tside copper wire with the carbon filament. Plati- m is also extensively used in the manufacture of e contact points of telegraph keys. Another im- rtant use for platinum, particularly in the United tates, is connected with dentistry, the pins by which tificial teeth are attached to the plate are constructed platinum, as it is the only metal known to be itable for the purpose, and it will remain unaltered the high temperature at which the teeth have to be aked. In the manufacture of sulphuric acid the ills, used for the concentration of the crude acid, are ften made of platinum alloyed with about 3 per cent. f iridium. Platinum is also used to some extent in wellery, but the quantity required for this purpose aries according to changes of fashion. Other uses re in the manufacture of platinotype paper for print- g photographs, in the construction of fine weights r chemists' balances, for surgical and other scientific struments, for making balance-wheels and hair- prings of non-magnetic watches, for obtaining a silver olour on porcelain, for platinum plating, for pro- ucing so-called "oxidised silver," and for the fuses of lectrically exploding dynamite cartridges. Although he existence of platinum in New South Wales had een suspected for many years, its actual discovery, in ayable quantities, dates so recently as 1893, and it is robable that, as fresh discoveries are made, an xtensive and valuable branch of the State min- ng industry will be created. The New South Vales platinum is obtained chiefly from the Fifield listrict, about 322 miles west of Sydney, where it is ound associated with gold. Here the principal vorkings are at Platina, a township situated about wo miles from that of Fifield, a deep alluvial "lead," ontaining platinum and gold, extending from near he former place for over a mile in length, and varying rom 60 to 150 feet in width. The sinking is from 0 to 70 feet, through loam, with some bands of arren quartz drift. The platinum and gold occur in airly coarse waterworn grains, and, as a rule, are con- ined to the cavities in the bed-rock, and to the wash- lirt for a few inches above it. Occasional nuggets of latinum have been obtained; the largest hitherto found veighs 27 dwt., and was purchased for the Sydney Geological Museum. There are two other nuggets n the Museum weighing 11 dwt. and 8 dwt. respec- ively. The washdirt contains from 5 dwt. to 12 dwt. of platinum, and from 1 dwt. to 3 dwt. of gold, per ton. The yield from 269 loads, taken from a nnmber of claims along the "lead," was at the rate of 6 dwt. 21 grs. of platinum, and 1 dwt. 23 grs. of gold, per ton. Platinum has also been found in the Broken Hill district, and in many other places; likewise on the beaches of the northern coast, where it is obtained from the auriferous sands. Here, the gold, platinum, &c., which are concentrated on the beaches during stormy weather, are brought down by the action of the waves, from an ancient beach deposit which occurs at an elevation of about six feet, and which has received the name of "black-rock" locally. This consists of a layer or bed of black sand-rock, composed chiefly of small zircons, with some grains of ilmenite (titaniferous iron), quartz, garnet, and tinstone, and also small but variable proportions of platinum, platinoid metals, and gold in a very finely divided state. The black colour of the sand-rock is due to organic matter, probably derived from swamp vegetation.

COAL, STEEL, AND IRON PRODUCTION IN FRANCE IN 1901.

Statistics of the production of coal, steel, and iron in France in 1900 and 1901, have recently been published by the Minister of Public Works. The figures for the former year have been corrected, and are definite; those for 1901 are provisional. The production of anthracite and bituminous coal in France in 1901, was 31,613,036 metric tons (tons of 2,204 lbs.), a decrease of 1,108,526 tons as compared with the previous year. The statistics do not separate the anthracite from the bituminous coal, but the amount of anthracite mined was comparatively small, being not over 450,000 tons, 82 per cent. of which came from the Department of Isère. Sixty-three per cent. of the output of bituminous coal was produced in the Department of the Pas de Calais and Nord, the Department of Loire coming next, with a little over 12 per cent. The production of lignite in 1901 was 688,721 metric tons, an increase of 5,985 tons as compared with 1900. Ninety-one per cent. of the total output of lignite was mined in the Department of Bouches du Rhône, Basses Alpes, and Vaucluse. The total production of mineral combustibles in France in 1901 was 32,301,757 tons, a decrease of 1,102,541 tons as compared with 1900. The estimated consumption of coal in France during 1901 was nearly 44,000,000 tons, a decrease of over 1,300,000 tons as compared with the estimated coal consumption of 1900. The falling off in the consumption and production of coal in 1901 was due to the unfavourable condition of French industries. The production of pig iron in France in 1901 was 2,400,240 metric tons, a decrease of 314,058 tons as compared with the previous year. The principal centres of production were the Department of Muerthe et Moselle, with 1,444,855 tons; Nord, with 266,570 tons; Saône et Loire, with 91,250 tons; Pas de Calais, with 84,961 tons; Landes, with 78,863 tons; and Gard, with 68,599 tone. There were 554,309 tons of manufactured iron produced in France during 1901, a decrease of 153,965 tons as compared with the year 1900. Of the total output there were 315 tons of iron rails, 501,928 tons of commercial iron, and 52,066 tons of sheet iron. The Department of the Nord leads in this production; then follow the Departments of Ardennes, Haute Marne, Seine, and Meurthe et Moselle. The total output of steel in France during 1901 was 1,151,170 tons, a decrease of 75,367 tons as compared with the steel production of

1900. There were 296,431 tons of steel rails produced, an increase of 18,237 tons over 1900; 580,376 tons of commercial steel, a decrease of 91,001 tons as compared with 1900; and 274,363 tons of sheet steel, a decrease of 2,603 tons.

AMSTERDAM EXHIBITION OF PHOTOGRAPHY.

An International Exhibition of Photography and Allied Industries will be held at Amsterdam, from August 28th to September 8th, 1902, in the Velox-buildings, near the Rijksmuseum.

The exhibits will be divided into seven classes:—

1st Class for Professionals.

2nd Class for Amateurs.

3rd Class, Allied Industries.—(*a*) Photogravure, heliogravure; (*b*) photo-zincography (half-tone blocks, line blocks); (*c*) photo-mechanical printing (collotype, Woodburytype).

4th Class, Scientific and Medical Photography.—(*a*) Astronomical photography; (*b*) colour photography; (*c*) micro-photography; (*d*) X-rays photography.

5th Class, Materials and Machinery in use of Photography and Allied Industries, exhibited by Manufacturers and Dealers.—(*a*) Utensils (optical instruments); (*b*) systems for artificial lighting; (*c*) furniture; (*d*) ingredients (chemicals, &c.); (*e*) frames and mounts.

6th Class, Various.—(*a*) Automatic photography; (*b*) bioscope; (*c*) cinematograph; (*d*) mutoscope.

7th Class, Literature.—Books, periodicals, &c.

Diplomas of honour, medals in gold, silver, and bronze will be awarded.

The Board of the "Nederlandsche Fotografenbond" Executive Committee, ask for help to make the Exhibition as complete as possible.

Application for further particulars should be made to Secretariaat Internationale Tentoonstelling van Fotografie en aanverwante vakken, Keizersgracht 533, Amsterdam.

MEETINGS OF THE SOCIETY.

COLONIAL SECTION.

Thursday afternoon, 4.30 o'clock:—

MAY 29.—"Western Australia: its Progress and Resources." By the HON. H. W. VENN. J. PARKER SMITH, M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 27.—"Pageantry and the Masque." By MISS MAY MORRIS. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., Vice-President of the Society, will preside.

MEETINGS FOR THE ENSUING WEEK

MONDAY, MAY 26...Victoria Institute (at the HOUSE THE SOCIETY OF ARTS), John-street, Adelphi, W. 4½ p.m. Annual Meeting. Address by Maj General Sir Charles Wilson.

East India Association, Westminster Palace Hot S.W., 4 p.m. Mr. S. S. Thorburn, "Education Newspaper."

Surveyors, 12, Great George-street, S.W., 3 p. Annual General Meeting.

Geographical, University of London, Burlingto gardens, W., 3 p.m. Annual Meeting.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8 p.m. Annu Oration.

TUESDAY, MAY 27...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. (Applied Art Section Miss May Morris, "Pageantry and the Masque."

Royal Institution, Albemarle-street, W., 3 p.m Prof. Carl Pearson, "The Laws of Heredity, wit Special Reference to Man." (Lecture II.)

Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m

Statistical, in the Examination Hall, Savoy-street Strand, W.C., 5 p.m. Monsieur Yves Guyot "The Sugar Industry on the Continent."

Photographic, 66, Russell-square, W.C., 8 p.m.

United Service Institution, Whitehall, S.W., 3 p.m Lieut.-Col. J. Baker, "Education and its Ancillary the Military Problem."

Colonial, Whitehall-rooms, Whitehall-place, S.W 4½ p.m.

WEDNESDAY, MAY 28...National Indian Association (at the HOUSE OF THE SOCIETY OF ARTS), John-street Adelphi, W.C., 4½ p.m.

Geological, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 5½ p.m. 1. Messrs. T. E. Thorpe and G. Stubbs, "Taxin." 2. Mr. J. W. Leather, "Soil Samples." 3. Mr. J. W. Leather, "Some excessively saline Indian Well Waters."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

THURSDAY, MAY 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section) The Hon. H. W. Venn, "Western Australia: its Progress and Resources."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 6½ Suffolk-street, Pall-mall, S.W., 8 p.m. Miss Ethel Halsey, "Rimini under the Malatestas."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Spielmann, "Contemporary British Sculpture." (Lecture II.)

Camera Club, Charing cross-road, W.C., 8¼ p.m. Dr. E. F. Grün, "A New Liquid Lens."

FRIDAY, MAY 30...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. G. Marconi, "The Progress of Electric Space Telegraphy."

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MAY 31...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Brander Matthews, "The Development of the English Drama." (Lecture II.) The Drama of the Middle Ages.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's Conversazione will be held at the Royal Botanic Gardens, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 p.m.

The Royal Botanic Society's Exhibition of Rhododendrons will be on view, and a special exhibition of roses and growing and cut flowers will be arranged by Messrs. W. Paul.

A selection of music will be performed by the String Band of the Royal Artillery and by the Band of the Scots Guards.

Further particulars of the other arrangements will be published shortly.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards will be forwarded in due course. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

APPLIED ART SECTION.

Tuesday evening, May 27; SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., Vice-President of the Society, in the chair. The paper read was "Pageantry and the Masque," by MISS MAY MORRIS.

A report of the paper and discussion will be printed in a future number of the *Journal.*

COLONIAL SECTION.

Thursday afternoon, May 29; J. PARKER SMITH, M.P., in the chair. The paper read was "Western Australia: its Progress and Resources," by the HON. H. W. VENN.

The paper and report of the discussion will be printed in a future number of the *Journal.*

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, April 17, 1902; SIR DENNIS FITZPATRICK, K.C.S.I., in the chair.

The CHAIRMAN said he did not think it likely that the paper his friend Mr. Preston would read would need any recommendation from him. As, however, there might be many present who were not familiar with Indian matters, he wished to say a word about the branch of the service to which Mr. Preston belonged, and about his position in that service. The Irrigation branch of the Public Works Department in India was, in certain ways, a peculiar service. The canal engineer not only had to be an engineer in the narrow sense of the word—a man capable of solving the original engineering problems which arose from time to time, but, as he had to work the canal as well as make it, he needed to be also a man of considerable administrative ability. The Government had been singularly fortunate in the Punjab in finding men who combined those two qualifications; he did not know how far it was the result of good luck, and how far it was the result of the tendency of the work to develop the man. He spoke from considerable experience, because in his early days, in Delhi, when he was a district officer, he had to do with the Western Jumna Canal, and again, at Amritsar, with the Baree Doab Canal, he had, in those days, much to do with the executive engineers and assistant engineers of the Irrigation branch. In his last years in India he, as Lieut.-Governor of the Punjab, was in direct contact with the heads of the department. Mr. Preston was not the chief engineer of the irrigation works in the Punjab at that time, but he was Superintending Engineer of the great Chenab Canal of which he would have a good deal to say presently. He (the Chairman) referred to those facts to show that Mr. Preston was in a position to address the meeting on the subject before them. If he had been asked to select the man most competent to deal with the subject of Mr. Preston's paper, he would have selected Mr. Preston himself.

The paper read was—

RECENT DEVELOPMENTS IN PUNJAB IRRIGATION.

By Sidney Preston, C.I.E.
(Chief Engineer Punjab Irrigation Works).

The last paper on the subject of irrigation in the Punjab laid before the Indian Section of the Society of Arts was read by Sir James Broadwood Lyall, in February, 1896. That paper gave a most graphic account of the various systems of irrigation in the Province, as well as a reference to the projects still to be carried out. In the present paper I propose to explain the details of one of the latest schemes for the irrigation and colonisation of a large area of Crown land, which, until the construction of the canal, had remained a vast waterless waste, bringing in little or no revenue to the State, but which promises, in the near future, to be one of the most productive tracts in the country.

The scheme to be described is the Chenab Canal, for the irrigation of the immense tract of country between the Ravi and Chenab Rivers, known as the Rechna Doab. I have selected this scheme because, although not the last, it is largely finished, and it is possible to give some statistics showing what it has already done, and to deduce from them its prospects for the future.

I do not propose to go at great length into the history of the development of irrigation in Upper India, but it seems necessary to refer to it briefly. The canals which we found in existence when we took over the Punjab were almost invariably situated in low ground, and were really the canalisation of drainages. There were a few main branches often aligned in subsidiary drainages, but no Government distributary system. Obviously the first improvement was to take the canals out of the drainages and align them on the watersheds; and this was done in the case of the Bari Doab Canal, constructed by Government, to replace the Hasli Canal, which had been made by Maharaja Ranjit Singh, to supply water to the Shalimar Gardens, near Lahore.

Even then, few distributaries were made by Government, the intending irrigators being permitted to take out large watercourses, which necessarily were of great length, to lead the water to villages situated at a distance from the main canal. In many of the older canals, these long village watercourses are still an immense evil. I have seen as many as six or eight running side by side for miles; many of them are eight and ten miles long, and apart from the difficulty of clearing the silt from them, the loss of water from evaporation and percolalation is extremely great. The second obvious reform was, therefore, to construct a scientific system of Government major distributaries, aligned on the minor ridges of the country, which would lead the supply in large volumes to villages distant from the canals themselves. This having been done, village watercourses were taken off from these channels, few, if any, outlets being allowed in the canals. This alone was a great reform, as it gave a much better control over the supply.

The next development commenced in the early eighties, on the Sirhind Canal, when it was decided that water should be delivered in a properly and scientifically aligned Government channel to the commanding point of every village, so as to place all villages on an equality with respect to irrigation facilities, as friction often arises when one village has to construct and maintain watercourses through the lands of other villages. Moreover, it was hoped that the saving of water by its being carried in well-maintained channels would warrant this additional expenditure. To effect this a system of minor distributaries was constructed from the major distributaries, the village watercourses being taken off either the major or minor distributaries as was most convenient in each case. So far we had in the Punjab only been dealing with settled lands, and the general idea was to give the share of water due to each village to the whole community, leaving the individuals to distribute it amongst themselves as they pleased. When we came to the development of waste lands into which settlers were to be imported from afar the circumstances were very different. The cultivator in a settled village, who, from the fact of his land not being commanded by the canal as designed, or from the ill-will of others in the village, did not get a share of the water was in no worse position than he was before the canal was made, he could still cultivate with the aid of rain as he did before. On the other hand, the waste lands had become waste, because the rainfall was too small to support cultivation, and the water too deep below the surface to permit of wells being worked. It was, therefore, necessary to guarantee that each individual should obtain a fair area of matured crops. This was not realised fully when the Chenab Canal was commenced, but the necessity soon made itself felt, and led to the minute system of levelling and water-channels shortly to be described. After the construction of the Sirhind Canal, which was opened in 1882, it became necessary to tackle the large areas of Crown waste land, situated between the rivers Sutlej and Jhelum. The first scheme opened with this object was the Sidhnai Canal from the south bank of the Ravi, near Multan. It was found necessary to go a step further than in the case of the Sirhind Canal, and in addition to constructing Government channels to the boundary of each new village, a main watercourse was made through the area allotted to the village. The object of this was to shorten the length of the field-channels which had to be constructed by the settlers before they could get the water on to the holding granted to them. A similar system was introduced in the Chenab Canal, but for the reasons already given, *i.e.*, that every individual must get a fair share of cultivation, it was found insufficient, and it soon became evident that to make the colonisation of the tract a success, the water must be led in a properly constructed and regular graded channel to the commanding point of each holding, before the settlers were brought in; and the phenomenal development of the Chenab Canal has fully justified this decision. It may be asked why such detail was not absolutely necessary for the efficient colonisation of the Sidhnai Canal. I am not prepared to say that it would not have been advisable, but the reasons that it was not absolutely necessary, are—(1) that the Sidhnai Canal was designed as an inundation canal with a much larger proportionate volume of water, and (2) that it irrigates an area in which the subsoil water-level is comparatively high so that irrigation from wells to supplement the canal is possible; indeed, the sinking of a well was made a condition of tenancy. Such is not possible in the Rechna "bar" where the spring water is generally about 100 feet below the surface.

As already stated, the Chenab Canal was not originally designed so completely; but accepting the experience gained on it, the still more modern canals, namely, the Jhelam, which was inaugurated at the end of October last, and the Lower Bari Doab—for which an estimate has been prepared, and is now under the consideration of Government—have been designed and constructed from the beginning on the system to be described.

It was originally decided that the whole of the Crown waste should be divided into squares of 1,100 feet side, this length having been decided on, as it fitted in with the local native land-measure of the district. The area of such a square is 27·78 acres, a somewhat inconvenient unit which is being remedied in the last scheme prepared, in which the length of side of the squares has been made 1,045 feet, giving an area of 25·07 acres. This is more convenient, as it is easily divisible by four lines parallel to the sides, into 25 compartments or fields, which, for all practical purposes, each measure an acre. Each cultivator is required to so sub-divide the squares of his holding, thereby immensely facilitating the registration and measurement of the irrigation, and minimising the chance of fraud by the petty measuring establishment. The squares into which the waste land is divided may then be represented by the diagram given as Figure II. on the wall.

I have already stated that every settler on being brought in is practically guaranteed irrigation annually for a certain proportion of the holding allotted to him; and in order to ensure this, it soon became evident that we must know the surface-levels all over the holding, so that the levels of the channels might be so designed as to allow of the water being able to flow on to the land from them; or, if from physical reasons this proved impossible, that the land might be reserved and not given out at all. We have, therefore, found it necessary to obtain the level of the ground at six or eight places on the boundary of each square as indicated by the red crosses on Plan No. II. These levels can be most systematically obtained by lockspitting on the ground a perfectly straight base line down the centre of the tract to be irrigated, and setting off at right angles to it other lockspits at intervals corresponding to the length of the side of the square into which it is desired to divide up the land. These cross lockspits are extended to the boundary of the Crown land to be blocked out on either side of the base. Levels are then taken along them at intervals of half and whole square lengths, each point being marked on the ground by a suitable peg or pillar.

It is obvious that when these levels have been taken, we have readings at about 500 feet intervals on lines 1,045 or 1,100 feet apart all over the country, and these, when plotted, enable the engineers to prepare an absolutely accurate contour-map of the country. The amount of levelling done is enormous, but it has proved not only to be time and money well spent, but absolutely necessary in the long run, and in the latest schemes it has, therefore, been done completely in the first instance, and the whole canal system designed from the levels thus obtained. The pillars at each level point are numbered systematically, so that in these immense wastes, it is possible to locate one's self immediately one finds a single pillar. The system adopted is as follows:—The first cross-line, namely, that starting from the origin of the survey, is numbered 0, the second 1, the third 2, and so on; the points forming the corners of the squares are similarly numbered 1, 2, 3, counting from the base-line on each side, the addition of the letter N. or S., showing whether the point on the cross-line is on the north or south of the base. Thus $\frac{10\text{ N}}{14}$ indicates the 14th point on the 10th cross-line from the origin on the north of the base-line. Until the waste is demarcated in some such manner it is impossible to find one's way about, and many times have the engineers lost themselves, have ridden miles trying to find their tents, and in some cases have had to spend the night under a tree owing to their failure to do so, as it is rare to come across even one of the nomads in these parts.

When the cross-lines mentioned have been laid out, it is only necessary to join the points forming the corners of squares by lockspits parallel to the base, as shown on Plan No. I., to complete each square, and this is done under the supervision of the settlement establishment by each settler directly he comes in, and he has then no difficulty in finding the limits of his holding. With a contour-map prepared from levels at such close intervals, it is easy for an engineer to design a system of canals located entirely on the watershed, while all the drainages, major and minor, are left clear to carry off the rainfall or surplus water poured on to the land.

The system of Government channels of the Chenab Canal is shown on the general plan reproduced herewith (Fig. 1, p. 605), and may briefly be described as follows:—It consists of a main line 40 miles in length, from which four large branches take off (one at the 28th mile, and three at the end); two of these branches themselves bifurcate in their 60th mile into smaller branches, and from all these branches the distributing system takes out. The bed width of the main canal is 250 feet, and it was designed to carry a depth of 9·6 feet of water, which was estimated to discharge 8,333 cubic feet per second. As a matter of fact, however, it has been found possible to run a depth of 10·8 feet, the volume discharged having been actually measured as 10,800 cubic feet per second. This is 30 per cent. more than that for which the canal was originally designed, and is six times the ordinary discharge of the Thames at Teddington. The large increase in volume over that originally planned has permitted the extension of the distributary system to much further limits than was at first contemplated. The original limits are indicated by a dotted red line on the general plan, but it is now hoped that the benefits of irrigation will be given to certain percentages of the whole of the "doab" down to the rivers Chenab on the north, and Ravi on the south.

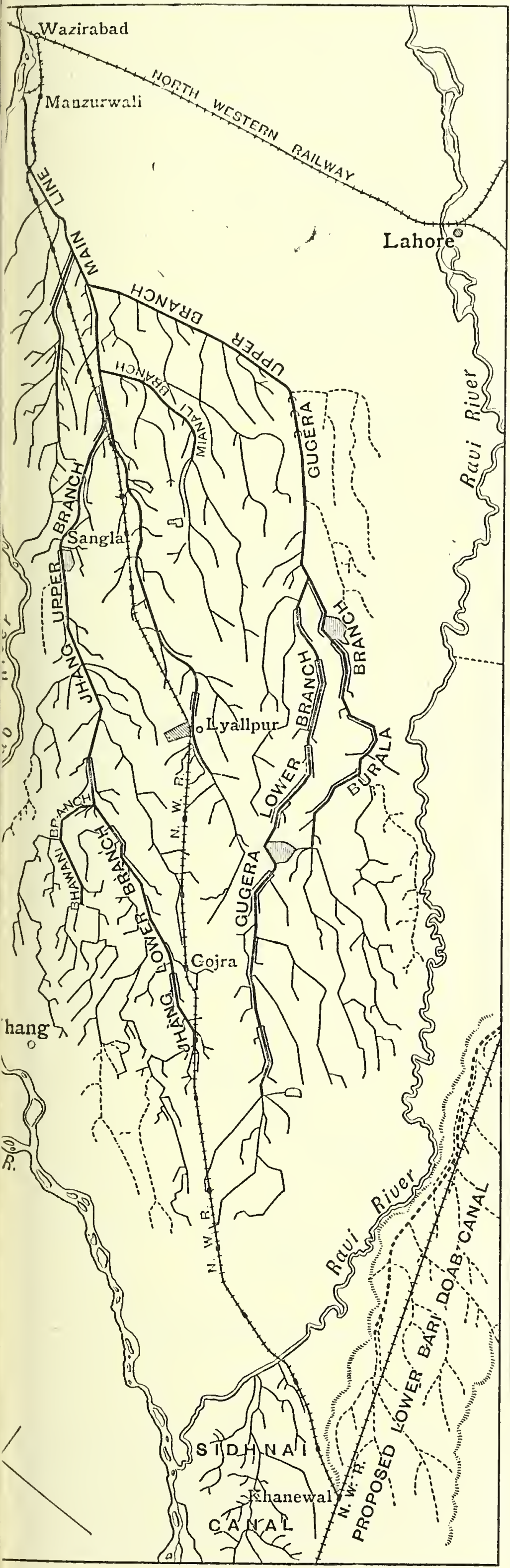
Up to the 31st March last, the following lengths of channel had been actually completed and brought into operation:—

Main Line	40	miles
Branch Canals	390	,,
Distributaries	2,059	,,
Total	2,489	,,

Since then many miles of distributaries have been sanctioned, shown by dotted lines on the general plan, and are now under construction, while many more are under consideration, and will be sanctioned from time to time as funds can be made available, as the completion of those now being built sets the establishment free to supervise them, and as it is made clear that water is available. Such then is the general scheme of this great system, which, during the past official year, matured 1,828,800 acres of crops valued at Rs. 506,36,419, equal to £3,369,000, and it hardly seems necessary to refer to the general scope of it more fully, as the main object of this paper is to explain in greater detail the arrangements which have made the colonisation of the waste land such a success.

It has been already stated that this success

1.—General Plan of the Chenab Canal.



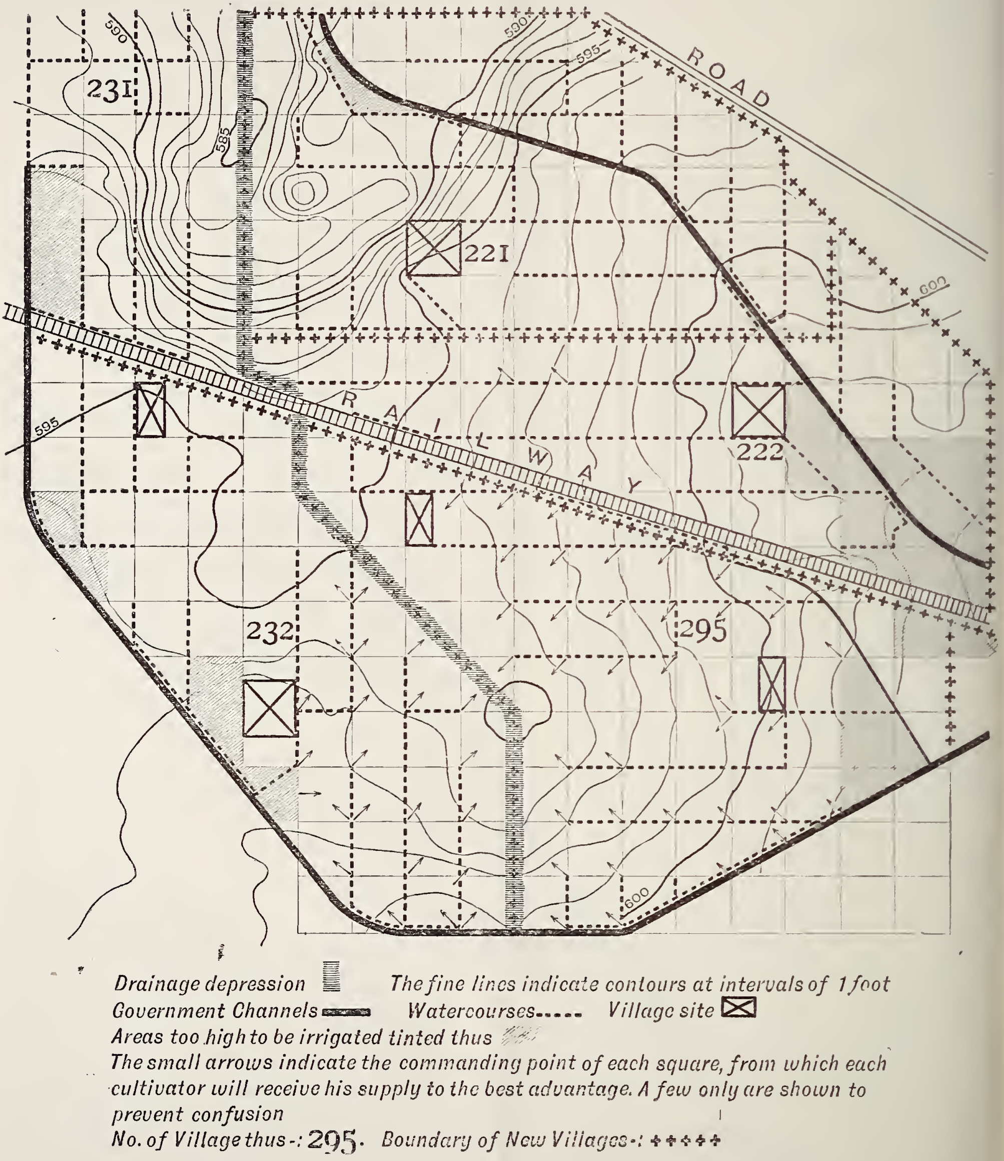
Walker & Cockerell sc.

has been largely due to the minuteness of the levelling operations, while the rapidity of the development has been due to the fact that a properly aligned and graded channel had been made to the commanding point of each square before the settlers were brought in.

Plan III. on the wall shows, to a larger scale, two of the canal branches, and the method in which the land is divided into villages. These are of varying sizes, the average area aimed at being about 50 squares, or 1,500 acres; but the limits of each village are obviously governed by physical considerations. The general principle has been not to have portions of a village on both sides of a distributary, as to do so would largely increase the number of bridges across those channels.

The drainage depressions of the country are shown by a green colour on the general plan, and these form the limits of the area commanded by various branches and distributaries. A certain width of land in the centre of these depressions has been reserved by Government, so that if necessary they can at any time be opened out for surface drainage purposes, and they also form natural boundaries for the villages bordering on them. When the whole area commanded by a given distributary has been blocked out into suitable villages, the watercourse system to irrigate each square in them is designed. This will be seen by Plan No. IV. (Fig. 2), which is a reproduction of the map of three or four villages. The contours are indicated by the curved lines; every five foot in level being indicated by a thick line, the intermediate levels at one foot interval being shown by thinner lines. The Government channels are in thick lines, and the watercourses in dotted lines. The small arrows indicate the commanding point of each square, from which each cultivator will receive his supply to the best advantage. A square, or in some cases two half squares, is reserved for the village site, and these are indicated with a large cross. The large hatched areas are too high to be irrigated by flow from the channels as designed, and are so shown as a warning to the colonisation officer that they should not be given out to colonists. Roads are constructed along the boundaries of every Government channel, and these, with certain main district roads, form the leading thoroughfares of the colony. Besides this, in conjunction with the watercourse system, a system of inter and intra village roads is constructed, the one being necessary to permit of the villagers getting from village to village or to the railway and markets, and the other to allow of each man getting to his holding from the village, without traversing his neighbours' fields. All these roads, and the thousands of culverts to pass the watercourses under them, are constructed by the Canal engineers at the same time as the channels themselves. The amount of supervision by the engineers which is required can be well imagined. Each channel of this gigantic system from the main canal itself to the smallest watercourse has to be specially designed; its capacity has to be calculated throughout its entire length, according to the area to be irrigated below any given point; the sections and slopes of bed have to be determined, as well as the size of each individual outlet from the distributaries, so that the distribution may be equitable. I do not propose to give any description of the works built on the canal; they are very numerous,

Fig. 2.—Showing the Division of Waste Land into Villages and the Details of the Irrigation System. The Squares are 1,100 feet side.



Drainage depression ▥ The fine lines indicate contours at intervals of 1 foot
Government Channels ▬ Watercourses.... Village site ☒
Areas too high to be irrigated tinted thus ▨
The small arrows indicate the commanding point of each square, from which each cultivator will receive his supply to the best advantage. A few only are shown to prevent confusion
No. of Village thus -: 295. Boundary of New Villages -: ++++

but, as a rule, of an ordinary kind. On the main canal they are very large, and often difficult to build, especially near the head of the canal, where the subsoil water-level is high, but the purpose of this paper being more to detail the irrigation arrangements than the engineering works, I will not refer to them more fully. In Plan No. V., on the wall, I have endeavoured to give some idea of the appearance of the waste land before we began operations on it. Some of it is well wooded, with three or four kinds of jungle growth, as indicated at A, and this also bears a good crop of grass fit for grazing when there is favourable rain. Some of the land is covered with a small scrub and camel thorn, as at B, and some is absolutely bare, producing nothing but a brilliant mirage which has often deceived the engineers into thinking a big breach had occurred, flooding many miles of country. The quality of the soil is easily estimated by the indigenous vegetation, and the settlers naturally like to get that which bears a thick jungle and grass as, although the former has to be cleared, it indicates the best soil. But although the quality of the soil varies, there is none which will not bear a crop of some kind when flow irrigation is available; even the worst land will grow rice at once, and, after five or six years in succession of rice cultivation, will grow cold-weather cereals.

The Crown land has been given out in various tenures, but the great proportion has been allotted in peasant holdings of one square. Each settler has been practically promised irrigation for 50 per cent. of his grant in the year, of which it is estimated 2-5ths would be in the rains or *kharif* crop, and 3-5ths in the cold weather or *rabi* crop. It is in order to comply with this promise, actual or implied, that it has been found necessary to carry out the minute distribution which I have endeavoured to describe. As a matter of fact, most of the cultivators have done much more than they were promised, as evidenced by the fact, that with a gross culturable commanded area of 2,646,000 acres, 1,828,800 acres were matured in 1900-1901.

In some tracts, the area irrigated has been excessive, and the subsoil water is already rising, so that, in extending irrigation to the tracts nearer the rivers, arrangements have been made for a more or less automatic reduction of the supply, as the subsoil water rises, with a view to preventing the evils of over-irrigation and consequent water-logging of the soil.

In the high or "bar" lands in the centre of the doab, there is little chance of this being an evil for many years to come, as the spring level is still 80 or 90 feet below the ground, and it can be easily drained, owing to the reservation, by Government, of the drainage lines. But in the lands bordering the rivers, this is far from being the case, and great watchfulness will be necessary to prevent the cultivators, in their eagerness to become rich, from spoiling the land for their descendants. The proposal which has been approved is, that while the spring level is more than 40 feet below the surface, water may be given for the irrigation of 50 per cent. of the culturable area in the year; but as the water level rises, the percentage of the total area for which water will be given will be reduced, and when the spring level is 10 to 15 feet below the surface, will be withdrawn altogether, or given only for one crop in the year to supplement the rainfall. Giving irrigation for the *kharif* crop only, will assimilate the conditions to those of the inundation canals which have proved such a benefit to the riverain tracts of the Ferozepore, Montgomery, Multan, Muzáffergarh, and Dera Ghazi Khan districts. An inundation canal is not combined with a weir across the river, and consequently can only obtain a supply when the river rises by the melting of the snows in the high Himalayas, or when it is in flood during the annual monsoon. As the river falls at the end of the rains these canals run dry, and the cold-weather crops which have been sown by the aid of canal water, are matured by the aid of wells. Not only, therefore, is there a cessation in the continuous pouring of fresh water on the land, but the subsoil water level is lowered by being drawn from numerous wells for six months in the year. It is hoped that the restrictions proposed will prevent the waterlogging which has unquestionably occurred in some districts from the older canals.

It has been said that by far the largest portion of the Crown land has been given out in peasant holdings; a certain area, however, has been sold by auction, partly because it was considered advisable to have a sprinkling of capitalists in the new colony, and partly to test the amount at which the cultivating natives valued the land. The results have been instructive. The first sale of between 9,000 and 10,000 acres of land occurred in March, 1892, just when the weir across the river, which was to make the canal perennial, was finished, but before it had really been brought into use.

The average price obtained was, I believe, Rs.47 per acre. A further sale of about the same area was made last year, the average obtained being Rs.114 per acre. The prices varied considerably; some villages which contained poor soil fetching only an average of Rs.30 an acre, while some went as high as Rs.141. Considerable areas have also been reserved for military pensioners, while larger grants than one square have been given to the headmen of villages, and to certain well-to-do and influential men. With a view to assisting the Bengal Cavalry Regiments to provide remounts, a village of from 1,500 to 2,000 acres is being reserved for each regiment, on which they can rear or breed young stock. Many of these have been already taken up and promise to do well. It has also been decided to grant land to certain Baluchis in return for the up-keep of service transport camels.

The peasant colonists have been selected from six or seven other districts of the Punjab, in which the population was somewhat congested. The selection of the colonists is made by the officer in charge of the district, and the engineers have nothing to do with the matter, or with their subsequent settlement in the colony, which latter work is in charge of a revenue officer specially deputed for the purpose, and in connection with this special scheme I wish to bear testimony to the valuable work done by Captain F. Popham Young, C.I.E., who for about eight years worked indefatigably, and to whom is due the entire credit of the division of the fields into the small squares shown in Plan No. II. The procedure is for the special colonisation officer to indent on one or two of the districts for a certain number of settlers of a particular caste, and the selection having been made, they report themselves to the colonisation officer in the colony, who causes them to draw lots for the different squares in the village to be given out. The settlers then go off and inspect the land, being shown the boundaries of the squares by a petty official from the lockspits and pillars already described. Some settlers occasionally refuse to accept the square which has fallen to their lot, because they do not like the look of the soil, and if the colonisation officer is unable to give them another square which meets their fancy, they return to their village disappointed. The great majority of course accept what has fallen to them, and go off to fetch their ploughs, bullocks, and seed. For the first crop it is not unusual to give the soil a watering, and then to spread seed on the ground and plough over it once. This would, of course, be considered slovenly cultivation, indeed not cultivation at all, in a settled village in which wheat land will be ploughed from six to eight times before sowing; but it suffices in virgin soil, and enables the new settlers to raise a considerable quantity of crop quickly. Some members of the family will then be left on the land to give periodical waterings, watch the crop, and begin rooting out jungle and house-building, while the remainder return to their old village and probably come back with the women and children about the harvest time. In some cases, however, the whole family, including many little children, come on to the land at once, and may be seen living in rough shanties made by covering some of the thickest jungle shrubs with grass, boughs, or old clothes. The life is hard and rough, but such is invariably the lot of a pioneer, and in this case the ultimate reward is certain and not very far distant. One of the original conditions of tenancy was that the settler was to bring half his grant under cultivation in the first three years, but it has been found quite unnecessary to impose the penal clause of forfeiture for default in this matter. Little jungle clearance is done the first crop, the ground between the shrubs being cultivated in the manner described above, and the jungle cut and the roots cleared out by degrees, until the whole has been cleared and the small hillocks levelled. One great reason for this is the system of initial remissions of revenue, which have been given most liberally on this canal.

The assessments on the Chenab, as on all the other perennial canals of the Punjab, are on the area actually matured, but the details are unfortunately extremely complicated, and will, it is hoped, be simplified in subsequent canals.

On the Chenab Canal the following rates are charged:—

1st.—A water rate.
2nd.—An owner's rate.
3rd.—A land revenue.
4th.—A *malikana* or rent.
6th.—Local cesses.

The owner's rate has been remitted for ten years, but besides that, all the other rates are remitted for the first two crops, and only half rates charged for the next two, so that it is only in the third year that full water rates, land revenue, *malikana* and cesses are paid. These liberal remissions have in my opinion been fully justified, and have largely assisted in the phenomenal development of the system. All the cultivators have tried to get as much land under cultivation in the first two years as they can, so as to obtain as much as possible for nothing, and they have, therefore, exerted themselves to the utmost to clear their holdings of jungle; this done, the cultivation of virgin soil is easy and profitable, especially in the years of scarcity which have unfortunately been too frequent in the Punjab recently.

I may, I think, usefully at this stage, contrast the results actually obtained, with those estimated in the project for the canal. The Chenab Canal was originally constructed as an inundation canal, to irrigate a portion of the area now commanded. Very shortly after it was opened, it became apparent, that however successful an inundation canal may be for riverain lands in which wells can be worked to mature the crops after the river falls and closes the canal, it is quite unsuited to the needs of the high lands which form the Rechna Doab. The canal silted heavily in the flood season, and as there was no means of forcing the water over the deposit, or of scouring it out, the water ceased to flow before the *kharif* or rains crop was matured, and before watering had been given to allow of the ploughing necessary to sow the cold-weather crop. The responsible engineers at once agitated for a weir across the river, so as to raise the low water level, and make the canal perennial. This was sanctioned in 1888, and as it was obvious that the full value of that work would not be obtained, unless the whole of the high land was brought under irrigation, an estimate was sanctioned in 1892 for extending the original canal, as now shown on the general plan. The enlarging of the canal was an engineering work of no small magnitude. The construction of the new branches and distributaries was no more difficult than the original canal, but the main canal had to be widened from a channel 109 feet wide, carrying 7·6 feet of water to one 250 feet wide, and carrying, as has been said, 10·8 feet depth. All the bridges had to be rebuilt; the channel itself regraded with falls introduced, and all this had to be done while the canal was still flowing and irrigation was developing. The funds and labour available were concentrated as much as possible; thus one division was employed in widening the main canal, while another constructed the Jhang Branch Upper. As it and its distributaries were completed, it was opened for irrigation, and work was commenced on the Bhawana Branch and Jhang Branch Lower. When these were ready, colonisation operations began on them, while the engineering staff was transferred to the Gugera Branch Upper and subsequently to the Gugera Lower and Burala Branches. Thus, as soon as any section of the canal was ready, it was opened, and began after the first year of remissions to earn revenue. The project estimate contemplated that the full capital would be expended by the end of the year 1899-1900, and that the irrigated area would increase from 39,300 acres in 1889-90 to 528,500 acres in 1899-1900; to 993,000 acres in 1909-1910, and that the full ultimate development of 1,100,000 acres would not be attained until 1914-15. What have been the actual results obtained? The weir was completed in the spring of 1892, and the canal at once served by it, with the result that in the year 1892-93 157,197 acres were matured. The subsequent development was as follows:—

Years.	Acres.
1893-4	270,405
1894-5	269,357
1895-6	369,935
1896 7	520,279
1897-8	810,000
1898-9	957,705
1899-1900	1,353.223
1900-01	1,828,800

while in the current year the irrigation to the end of January had amounted to 1,920,240 acres.

Up to the 31st March, 1901, a total area of 1,466,125 acres of Crown land had been allotted, while the census taken in that month showed that close on 800,000 souls had been imported into it. Several towns of considerable size have been built. Lyallpur, so called to commemorate its foundation in the Lieutenant-Governorship of Sir James Lyall, now contains from 8,000 to 10,000 inhabitants, while Sangla, Gojra, and other towns are progressing rapidly, and are large markets for the export of the produce. The villages have been laid out on a uniform and sanitary plan, and are rapidly springing into existence all over the whole tract. It may, I believe, be safely prophesied that this canal will in time irrigate as much as 2,500,000 acres in the year, raising crops which may be valued at £5,000,000 sterling. You may be interested in hearing what this scheme has cost, and the return Government is likely to obtain from it. The original estimate amounted to Rs. 256,84,175 for a canal to discharge 8,333 cubic feet per second, which it was estimated would ultimately irrigate

1,100,000 acres in the year. To the end of 1900-01 the sum of Rs. 252,63,656 had been spent on a canal which can carry 10,800 cubic feet per second, and in that year matured 1,828,800 acres of crop, and is still undeveloped. It may, as already stated, be said to be certainly able to irrigate 2,500,000 acres when possibly another 20,00,000 or 30,00,000 rupees have been spent on it. In 1900 01 the net revenue assessed gave a return of 18·18 per cent. on the capital, but this is allowing the large remissions already mentioned, and it has been calculated that if the area actually matured had been assessed at the full rates (which are by degrees coming into force), the nett revenue, after deducting working expenses, would have yielded a return of 24·58 per cent., and as the Indian Government can, I believe, borrow money at 3¼ or 3½ per cent., it is an eminently satisfactory investment. It must not, however, be thought that this high return is obtained by impoverishing or grinding the cultivator. The crops matured by the canal in 1900-01 are estimated to have been worth Rs. 506,36,419. Of this, Government only took between ⅕th and ⅑th, leaving the large balance of Rs. 447,16,325 for the cultivators. If further evidence of the fairness of Government is required, it will be found in the crowds of applicants for land which surround every officer during his tours in the Punjab, although the amounts of the assessments are now well known.

There is one other point to which I should refer, before closing my remarks with regard to the Chenab Canal. You will perhaps wonder how the distribution of the water is effected so as to ensure its reaching the millions of fields into which the vast area is divided. When the supply in the river is in excess of the full supply of the canal, this is a comparatively easy matter. If the demand warrants it, the canal is then run full, which, in turn, gives full supplies to all the branches and distributaries. The difficulty really begins when the supply falls below the requirements, and it is then that the energies and intelligence of the canal staff are taxed to ensure a fair distribution, and mature as large an area as possible. This, of course, occurs in the cold weather. Still taking the case of the Chenab Canal, the river usually remains fairly full until the middle or end of October; this gives ample supply for cold weather sowings. Should the cold weather rains fail, the crop will be entirely dependent on the canal, while the total discharge of the river will probably not exceed 4,000 cubic feet per second. If the water wer available, it is probable the canal would b run full more or less steadily, but the volum to do so not being available, the whole volum in the river is passed into the canal, and distributed to the different branches in rotation Some years ago the system followed was t distribute the supply between all the branches running each steadily with the share of th supply available due to it. It is obvious tha with this system the distributaries could no run full; with the result that lands which wer high did not receive water, the depth in th channel not being sufficient to flow on to thes high lands; the water was drawn off by outlets serving low lands in the middle reaches of th distributaries, and little or none reached the tails, with the result that there was heavy failure of crops in the tail villages. This has now been altered, and the reduction necessary is made in time instead of in volume. Thus every distributary when opened at all, is run full, so that all the outlets on it work fairly and as designed, and the tail villages now obtain as good a supply as those at the head.

When any given distributary has received its allotted time of full supply, it is entirely closed and the water passes into others. The art of good administration lies in correctly fixing the periods for which each distributary is opened, so as to utilize to the best advantage the supply available, and to take advantage of any freshets which may come down the river owing to rainfall in the catchment area of the river above the weir. Thus the system must be so designed that if to-day 4,000 cubic feet are being received, we can to-morrow distribute 8,000 or even 10,000 cubic feet if that volume reaches the canal head. To do this it has been found necessary to have a private telegraph line extending all over the system, so that every officer and subordinate may be at once informed what volume is available and which channels are to be opened. The new system has also the enormous advantage of economising water, as the shortest length of channel is kept wet, and consequently the loss by absorption and evaporation is reduced to a minimum.

Coming now to the cultivators. I have already said that the watercourses which are in their charge take off from the distributaries, and the irrigators have authority to open the sluice at any time there is water flowing in the distributary, unless a special order of closure has for any reason been given by competent authority.

The distribution of the supply in the watercourse between the cultivators dependent on it is done in accordance with a share list, which gives each man the right to use the whole supply for a certain period, during which time he may irrigate as much as he can. If he has been unable to water the whole of the area he has under cultivation in the time at his disposal, the area unwatered must wait until his turn comes round again, in 15, 21, or possibly 30 days' time. The period during which each man has the use of the water is invariably a multiple of four hours, so that a man may get water for 4, 8, or 12 hours. In some cases a watercourse is so large that it discharges a volume too big for any one man to deal with, and in that case the total area commanded is divided into blocks, each of which is served by a branch of the main watercourse, and the system described above is then applied to each branch watercourse. The cultivators know exactly when each man's turn is up; and in times of tight supply and keen demand, the next shareholder will be waiting ready with his spade to take over the watercourse and turn the water on to his own land directly the turn of his predecessor is up. Needless to say, disputes are not infrequent, and have to be adjudicated on by the canal officers, who are given magisterial powers under a special Canal Act, to dispose of them legally.

One great object of the canal engineer, is, of course, to get as good a duty from the water as possible, *i.e.*, to mature the crops with the least possible volume, as not only does he thus earn the best returns for the canal, but he saves the land from the evil of over saturation. A fair duty is 100 acres of crop per cubic feet per second (on the average supply entering the canal at the head) in the rains; and 200 acres in the cold weather; and this is what is aimed at and often obtained. This means, that one cubic foot per second, running continually, will mature 100 acres in the rains crop, and 200 acres in the cold weather, or 300 acres in the year. The same idea can be expressed differently, namely, in terms of the depth of water poured on to the land; it represents a depth of 3·6 feet in the rains crop, and 1·8 feet in the cold weather, which we may say corresponds with 43·2 and 21·6 inches of rain respectively. It is obvious that the duty must vary immensely, not only from year to year, but between different localities in the same year, according to the quality of the soil, and also whether the canal is assisted by timely rainfall or not. It must not be supposed that 43·2 or 21·6 inches of water actually reaches the fields; it has been estimated that from 60 to 70 per cent. of the water is lost on the way; at any rate, it is probable that not more than half the depth given above actually reaches the fields.

I have only one more remark to make before I leave the Chenab Canal. Very early in its history it became evident that a railway to remove the produce was absolutely necessary, and the canal and revenue officers agitated for its immediate construction. This requisition came on the railway branch of the Public Works Department unexpectedly; such a line had not been contemplated in the programme then in operation, and it was some time before funds could be made available, and the line from Wazirabad to Multan, passing through the length of the colony, constructed. It is not too much to say that the colonisation scheme was within an ace of proving a failure from the impossibility of the colonists getting rid of the enormous quantity of produce, and raising cash to pay the Government demand. This had now been so fully realised that, in the case of the more recent Jhelum Canal, a similar railway is now being laid down the centre of the Jech Doab, and a considerable portion of it will probably be finished and open for traffic before any settlers are brought in at all, or new lands opened out.

As the question of irrigation has been so much under consideration in connection with the famines which have been so frequent of late, it will be interesting to record what has been done by the Punjab Government besides the large scheme just described. Sir James Lyall in his paper of February, 1896, stated that there were still three large tracts of waste land to be developed. The first of these is the Jech Doab to be irrigated by a canal from the Jhelum. Good progress has since been made on this scheme. The head works, main line, and the northern branch and its distributaries were completed by the end of last year, and the canal inaugurated by the Lieutenant-Governor on the 30th October. It irrigated some 12,000 acres during the last rain crop, and I heard yesterday that it had done 50,300 acres during the current crop to the end of February. There is, of course, a good deal of work still to be done in completing the southern branch and its distributaries, as well as the watercourses, roads, and culverts for the development of the Crown lands on the lines described, but the heavy work has been done, and rapid progress will probably be made in the completion of the scheme.

The second scheme is for the development of the Crown land of the Montgomery and Multan districts at the lower end of the Bari Doab. The whole of this has been levelled at 1,045 feet intervals, and a careful contour map prepared, from which a scheme for a canal from the River Sutlej, to discharge 3,800 cubic feet per second, has been worked out in detail, estimated and submitted to the Government of India in October last. If recommended by that Government and sanctioned by His Majesty's Secretary of State for India, work will be started on the main line. Owing to the peculiar situation of the head works, and the alignment of the main line, partly in the Sutlej *kadir* or low land and partly in the "bar" or high land, which latter is already irrigated by the Upper Bari Doab Canal, this canal will be the most expensive and the most difficult to construct which has yet been undertaken in the province, but it is certain to be very remunerative both directly and indirectly.

Since the above was written I have received a copy of an extract from a note by the Irrigation Commission, in consequence of which there is likely to be some delay in starting this work. I may suitably read its recommendation, in accordance with which orders have been issued by the Government of India. The extract is as follows :—

> "The Commission recommend that the construction of the canal be deferred until its probable effect on the Ferozepur and Sutlej systems of inundation canals in the Punjab, and on the canals of the Bahawalpur State has been furthered considered, and until the general lines have been laid down of a complete scheme for protecting, and, if possible, extending the irrigation of those canals."

The third large tract is the *Thal* of the Dera Ismail Khan, Shahpur, and Muzaffargarh districts. The area is approximately 5,000,000 acres. The land mainly belongs to the people, but a Bill has recently been passed in the Punjab Legislative Council to enable Government to take over three-fourths of it for the purpose of colonisation, on condition that it makes a canal. It has been always known that there is an immense quantity of sand in the *Thal*, but the feasibility of making a canal in it does not seem to have been questioned until last year when I visited the tract, mainly with a view to determining how the detailed surveys of it should be carried out, as from what I h heard it seemed to me possible that the syst followed in the case of the Rechna, Jech, a Lower Bari doabs would be inappropriate. must admit that I was astonished at t enormous masses of sand hills, and I have f bound to sound a note of warning as to t likelihood of any large scheme of irrigati being possible or profitable in this tract. It w only possible for me personally to take vario rides through the tract and form a gener opinion; to enable a more definite conclusi to be arrived at, a strong reconnaissance par under a senior executive engineer, was se out in November last, and has been at wo the whole cold weather, surveying pieces of t various types of the country. This officer report will be of great interest, not only to can engineers who have for years looked on th Sind Sagar Canal as the great scheme of th future, which would eclipse all others in siz but to the revenue officer who has been lookin forward to the development of this vast trac to increase the prosperity of the Province.

So much for the three large projects whic Sir James Lyall stated in 1896 remained to b carried out. But besides these, considerabl extensions have been made on most of th other canals. For the Bari Doab Canal, ver considerable estimates have been sanctione in the past year for extensions all over th system, and these are now under construction The extension of the Swat River Canal across the Kalpani Nullah, alluded to by Sir James Lyall, has been finished, as well as another through a ridge of hills to an irrigable tract near Nowshera. On the Western Jumna Canal the distributary system, which in 1894-95 aggregated 1,690 miles, has been increased to 2,210 miles, mainly by extensions into the dry tracts in the south-east of the Province. On the Sirhind Canal, 252 miles of new distributaries have been added in the same period. On the Lower Sohag and Para, and on the Sidhnai Canals, the extensions have not been so large, although on them, too, something has been done, as well as on all the inundation systems.

The inundations systems are the least efficient in the Province, mainly owing to the want of a proper distributary system. Successive chief engineers have done what they could to remedy this, but they have been hampered by want of funds. These canals have always been charged to the revenue head of accounts, under which it is always more difficult to obtain funds than under pital. This difficulty, and the urgent need improvement in the inundation system, re prominently brought to the notice of the dian Irrigation Commission when it sat in e Punjab, and I sincerely trust that its commendations will lead to an alteration in e system which will give us the funds to ake the inundation canals as efficient as the rennial ones.

In regard to this question, the Irrigation ommission have written as follows in its note the Lower Bari Doab project:—

"We shall dwell elsewhere on the importance of modelling the principal inundation canals, and oviding them with a proper distributary system, by hich a greater economy of water will be attained, hile the expense of irrigation to the cultivator will very considerably reduced. We consider that is work should not be postponed."

This is very hopeful.

In conclusion, I may state that at the end 1900-01, the Punjab canals comprised:—

ain Line	3,000 miles
ranches	1,622 ,,
istributaries	11,723 ,,
otal length of Government channels..	16,345 miles

hese matured 6,000,551 acres of crops, which the largest area yet attained, but which, by e developments I have attempted to describe, ill continue to be exceeded year by year for me time to come. As evidence of which I ay state that to the end of January about ,563,574 acres had been irrigated during the urrent year.

DISCUSSION.

The Chairman expressed the indebtedness of the eeting to Mr. Preston for his very able paper on the reat Chenab scheme, in connection with which so uch credit was due to him. The credit of isisting upon the conversion of the Chenab Canal om an inundation canal to a regular one, was due Colonel Ottley, while to Colonel Jacob belonged the raise for extending the converted scheme, so as to ake it embrace the entire high land of the Doab. hen followed Mr. Preston as Superintending Engieer, and the rest of the work was carried out under is supervision. As some of the figures mentioned y Mr. Preston were well worth carrying away with ne, he recapitulated the most striking. Over two illion acres of crops per annum were under cultivaon, and the work paid over 18 per cent. on the apital expended on it, and that without any undue ressure on the agriculturist. And there still emed to be as keen a demand for land as in the days when he himself was in the Punjab. In those days, wherever he went he was mobbed by people asking for land on the canal. There could be no better proof of the easy terms on which the land was let. The results had far exceeded those originally anticipated. Another very satisfactory feature of the matter was the way in which the agriculturists had fulfilled their engagements. In giving out the land, it was necessary to impose upon the cultivator certain conditions, and having regard to the great difficulties of bringing land into cultivation at a distance from the people's homes, and in a wild tract of that sort he thought it would become necessary to let them off their obligations to a considerable extent. But the holders, of their own accord, and without any pressure from the Government, had fulfilled their obligations and had even cultivated more land than they were bound to. He felt that such a result was largely due to the kind of officers who had the work in hand. It was the good fortune of the Government to command in succession the services of such officers as Colonel Ottley, Mr. Higham, Mr. Beresford, Colonel Jacob, and Mr. Preston. As colonisation officer Captain Popham Young was an exceptionally able, energetic, and resourceful official, a man, moreover, of great patience and one who showed much consideration to the people. With regard to the danger on the proposed Lower Sutlej Canal to inundation of canals lower down, he thought that matter was considered by Colonel Ottley, with whom it was a very favourite scheme. The Indus Canal scheme was for a long time looked upon as likely to be the crowning point of the work. But, as Mr. Preston had stated, a note of caution had recently been sounded. It might be a question whether, on investigation, the field would be found to be so extensive and magnificent as was at one time supposed. Moreover, he believed the silt in the Indus was not so beneficial as the silt in the Chenab, but as to the great importance of the work, there was no doubt. The only complaint he had to make about Mr. Preston's paper was that there was not enough of it; but it was necessary to impose a time limit. There were various questions which had not been touched—engineering, agricultural, economical, sanitary, revenue, and administrative questions, but if they were to be dealt with they would require a course of lectures.

Colonel J. W. Ottley, R.E., C.I.E., said he did not know whether Mr. Preston should be more heartily congratulated on his excellent paper, or on his good fortune in having returned as Chief Engineer to the Punjab in time to see the Chenab Canal in all its glory and to open the Jhelum Canal. Mr. Preston had not had to encounter the enormous difficulties which beset his predecessors, for these difficulties had to a great extent disappeared when Mr. Preston took over charge. What was now common knowledge and accepted truth was twenty years ago confined to few men, who were regarded by some of their contemporaries and by most of their seniors as hopeless cranks and visionaries. The work would never have been carried through but for the loyal assistance of the executive officers, among whom he wished to specially mention Mr. Benton and Mr. Kennedy, who were among the earliest products of Cooper's-hill College, of which he had the honour to be now President. When any trouble occurred in connection with the distribution of water, in the early days of which he was speaking, there were practically no levels to go upon, and, indeed, very little information of any sort, and the hopeless state of the engineer in those circumstances could scarcely be imagined. The first thing to do was to complete a close network of levels such as those in the Chenab, of which Mr. Preston had spoken. He believed the Bari Doab levels were the first of this kind ever carried out, and to obtain them was slow work, as there were only two or three surveyors, very little money, and very few instruments. The Chenab Canal was designed as an inundation canal, but the canal was not completed before it was discovered that it ought not to be such. He was the officer deputed to lay out the canal, and after a preliminary examination he pointed out the unsuitability of an inundation scheme for this tract, and said it should either be made a perennial canal, or else given up. He had still by him the answer he received to his recommendation. It was to this effect: "Drink as much cold water as you like, but do not pour it over this project. Don't bother your head about permanent canals and weirs. You might as well cry for the moon, which you would have as much chance of getting, as funds for the magnificent project you outline. So please do what you are told, and millions, yet unborn, will bless the day when J. W. O. was sent to the Rechna Doab." Suddenly, in the middle of a Punjab hot weather, he received a telegram to send an officer to prepare a project for an inundation canal from Ramnagar in the Rechna Doab, the project to be submitted, if possible, within three months. As he had no officer available he started off himself, taking a surveyor in whom he had confidence. The task was to survey as much as possible of 900 miles out of the 4,000 square miles of this waterless tract, at the worst time of the year. The most that could be done in the time was to submit a sketch map of a very small portion of the tract, and to lay out the line of the canal for a comparatively short distance. It was not so much want of knowledge which troubled them, but want of time, funds, surveyors, and instruments. It was the repetition of an old story. The preliminary work of the Bari Doab had been carried out by two young officers, neither of whom was a trained engineer, and the only marvel was how, subsequently, two young lieutenants of Engineers ever managed to build the magnificent work entrusted to them. It would remain for ever a monument to the genius of Dyas and the officers associated with him. As regards the Chenab, he thought it should be understood that all the details which had been mention were foreseen and worked out by the original builde perhaps not in their present form, but the ger were laid. Mr. Preston had said the railway w an absolute necessity and without it the canal wou have been a great failure. But his (Colonel Ottley persistent advocacy of that railway incurred for h the grave displeasure of the then Member of Counc He wished specially to mention the name of the m who years ago foresaw all that must happen, a whose extraordinary prescience in the matter ought be fully acknowledged. He referred to Col Sydney Long Jacob, who might fairly be termed t father of the extended Chenab Canal. That so litt progress was attained in the spread of irrigation to fifteen or twenty years ago was to be account for partly by want of knowledge on the part of t establishment, but mainly to the want of funds a men. For many years irrigation was thorough discredited. That so much progress had been ma of late years was largely due to the support of h two chiefs—Sir James Lyall and Sir Dennis Fit patrick. He was sorry to hear such a poor accou of the Sind Sagar Doab. He did not know t country, but thought that before pronouncing finall Mr. Preston should visit Sind and see there t way in which irrigated cultivation wiped out sandhill He spoke very highly of the capacity and charact of Captain Popham Young, and related an incide to show that officer's desire to make the cultivato comfortable, even at the cost of self-denial.

Colonel S. L. Jacob, R.E., C.I.E., said Colon Ottley had alluded to the great difficulties und which irrigation officers carried on their operation So far from having exaggerated them, he had n stated them sufficiently strongly. The representations made were not believed. In framing the Chena project it was said that the irrigation would be muc more than 1,400,000 acres, but in order to take awa every possible ground for the idea of exaggeration th returns were calculated at 1,200,000, and that onl after a long period. But before it was sanctione the acreage was cut down, and the time wa lengthened. That was why the estimate came out s much less than the actual. It was quite true tha the people on the canal were thoroughly prosperous and that they had more than fulfilled their obligations But, in a way, they were too well off, *i.e.*, when compared with the condition of the people in the unirrigate land in the south-east. Mr. Preston had shown ho great had been the strides made, and prophesied tha 2,500,000 acres would be irrigated, assuming a duty o 100 in the hot weather, and 200 in the cold weather But all those things would have been laughed t scorn a short time ago. Four years ago, when h told the then Chief Engineer of the Panjab that th Chenab Canal would irrigate 2,000,000 acres, he said "impossible," and proved it to him by mathematics, but mathematics did not correct erroneou data. Just as there had been strides in th past, so there would be in the future. He thought the time had come to take another forward step, and look upon the province as one whole, or even to go outside one province and work out the proper use of water in connection with two provinces. In the north and west there was a superfluity of water available, and in the south and east a superfluity of dry arid land, which required water, but water was scant. An effort should be made to at least place the south and east above the fear of famine, though it would never be as prosperous as the north and west. There would be an immense waste of capital if the water available were not utilised. In the Punjab, water was gold; it was the capital and the blessing of the country. Given water, the Punjab could become the granary for all India. He agreed that the carrying out of his ideas meant great expense. But if it were done, the lack of profit in one part could be made up by the profit in another; and it would be immensely remunerative in immunity from famine and in the prosperity of the people, for in the welfare of the people was the prosperity of Government. In the incomparable project which had been dealt with there was too small a commanded area. The irrigation officers would have liked much more land at command, so as to get the fullest value out of the water. Again, as to the Jhelum river, which was a little larger than the Chenab, there was only a tiny plot of land, so that no more than half the available water could be used for it. Was that water to be thrown away for ever? He thought it was possible to do more from the waters of those rivers than was contemplated, and, without touching the water of the Sutlej, to water the whole of the land completely down to the Sutlej valley, leaving the whole of the Sutlej water for the left bank. With regard to the south-east, though it would be costly, there was a possibility of making the south and east thoroughly famine proof. This should be done by developing the irrigation in the Hissar and Rohtak districts on the existing distributaries and by making new ones. Supplies should be reduced on water-logged tracts where the spring level is within 15 feet of the surface. To help in making this part famine-proof the Jumna should be more freely drawn upon and some of the flood water utilised and torrents canalised. Though expensive, it would also be quite possible to obtain large additional volumes of water by pumping it from the water-logged spongy soil passed through on the upper part of the canal. There is any amount of water power between Tajawala and Dadapur to work electric plant for pumping purposes. This, however, being expensive would only be resorted to when the other means were exhausted, but certainly the south-east Punjab should be lifted above the possibility (humanly speaking) of famine.

Sir Evan James, K.C.I.E. (late Commissioner in Sind), said that, having visited the Chenab Canal himself during 1897, when a part of the Punjab was suffering from grievous famine, he could testify to the valuable results. It was a pleasure to travel through and see the evidences of prosperity. In Sind, while he was there, a grand, new canal was brought into existence, not so large as the Chenab Canal, the cost being £600,000 or £700,000. As the Punjab was over-populated, Sind was under-populated, and it fell to his lot to decide how to colonise it, how to arrange the distribution of the water, and, generally, the newly-irrigated waste; how to administer the canal. He went to the Punjab and saw Colonel Ottley, to whom they owed a debt of gratitude for the able way in which he had revised the plans for the dam, and other details of that canal. The Jamrao Canal, in fact, repeated in many respects the history of the Chenab Canal, and was going to be managed scientifically on the same lines, and would be quite as great a success. He gave examples of the industry of the people in working the land, by which they brought out the figures of cultivation and revenue much higher than the estimates. One point referred to by Colonel Ottley and Colonel Jacob was the proposal to make an enormous extension of irrigation in the Punjab. But if that happened, without very full consideration, there might be civil war in India. Water questions in India raised most bitter strife, and if the Commissioner in Sind was like a native potentate, he would endeavour to destroy any new dams which took more water out of the Indus. He was Chairman of a Committee of Development of Sind irrigation a few years ago, when it was proposed to take a canal out of the Indus at Sukkar, giving a cold weather supply of 18,000 cubic feet per second. The engineers strongly advised that that would be too dangerous. In the Punjab there were five rivers. Those could be tapped, but the Indus should be left for the boats to sail upon, and as a reservoir for the irrigation of Sind.

Mr. Preston, in reply, said he agreed with Colonel Ottley, but it was obvious that an hour would not suffice to go into all the details. He mentioned Captain Popham Young because, being outside his (Mr. Preston's) department, he was glad of the opportunity of mentioning the good service he had done. Colonel Jacob's remarks called for some reply. He drew a diagram illustrating the general direction of the rivers of the Punjab which showed the difficulties and the expense which the scheme of Colonel Jacob would involve. He stated that Mr. Wilson, the present Settlement Commissioner in the Punjab, suggested the same idea, and it was still before the Irrigation Commission now sitting. The scheme was an enormous one, and would require a great deal of detailed consideration. One great objection to it was that it would mean taking an enormous channel right across the whole drainage flow of the country. Colonel Jacob had not stated whether he contemplated crossing the rivers by aqueducts or to build weirs on them. He referred to the enormous loss incurred by the North-Western Provinces when the Nadri Aqueduct of the Lower Ganges Canal failed in 1892; and Colonel Jacob knew how many Nadri Aqueducts would be required for the 10 or 12-mile valley included in his proposal. He bore testimony to the enormous amount of work done by Colonel Jacob in developing the Western Jumna Canal, and said that he had suggested to the Irrigation Commission a still further reduction of the volume of water given in the Kurnal and Delhi Districts, so as to make a larger supply available for the dry tracts in the south-east of the Province. In reference to Sir Evan James's remarks about the Indus, he would only say he had made, before the Irrigation Commission, suggestions that the time had come when the Government must go in for a large development of weirs all over the rivers. He believed that in the near future it would be found advisable to build two or three more weirs on the Sutlej in addition to the one required for the Lower Bari Doab Canal in order to ensure early and late supplies to the inundation canals. One would also probably be built on the Chenab for the supply of the canals on both sides of the Chenab river. It was only a question of time for the same thing to be done on the Indus. Sind must do the same.

On the proposition of the CHAIRMAN, a cordial vote of thanks was accorded to Mr. Preston for his valuable paper.

Obituary.

W. M. ORD, M.D., F.R.C.P. — Dr. William Miller Ord, Consulting Physician to St. Thomas's Hospital, died on the 14th inst. at the residence of his son, at Salisbury. He was born in 1834, and received his medical education at St. Thomas's Hospital, which institution he entered in 1852, and there he took all the principal scholarships and prizes. In 1852 he became a member of the Royal College of Surgeons, and a licentiate of the Society of Apothecaries. In 1857 he passed the M.B. examination at the University of London, and he became a Member of the Royal College of Physicians in 1869, and a Fellow in 1875. He graduated M.D. in 1877. He held a succession of offices at St. Thomas's, and his connection with this hospital lasted for fifty years. Dr. Ord was an active member of many professional and other scientific societies, to some of which he contributed papers. He was appointed by the Clinical Society chairman and director of the investigation into the subject of myxœdema, a disease with which his name is intimately associated. He edited in 1881 the collected works of his friend, Dr. Francis Sibson, to which he added a memoir of the author. He was elected a member of the Society of Arts in 1891.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 2...Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Charles Rous-Marten, "Some Twentieth Century Locomotives."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. Philip Schidrowitz, "A Contribution to the Chemistry of Whiskey. I." 2. Dr. A. Dupré, "The Estimation of Perchlorate in Saltpetre, &c." 3. Dr. Robert Robertson, "The Will Test for Nitrocellulose." 4. Dr. O. Silberrad, "The Effect of the Alcohol Duty on Chemical Industries."

Actuaries, Staples-inn Hall, Holborn, E.C., 5 p.m. Annual Meeting.

TUESDAY, JUNE 3...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Carl Pearson, "The Laws of Heredity, with Special Reference to Man." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. R. Lydekker, "The Wild Sheep of the Upper I and Lower Lena Valleys." 2. Dr. R. Broom, "Differences in Dicynodont Skulls." 3. Mr. F. E. Beddard, "The Gonad Ducts and Nephridia of *Eudrilus*."

WEDNESDAY, JUNE 4...Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Henry J. Elwes, "The Butterflies of Chile." 2. Mr. S. L. Hinde, "The Protective Resemblance to Flowers borne by an African Homopterous Insect."

Archæological Association, 32, Sackville-st. W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Royal Archæological Institute, 20, Hanover-square, W., 4 p.m. Papers by Mr. Herbert Jones and Dr. Robert Munro.

THURSDAY, JUNE 5...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. H. W. Pearson, "Certain Species of *Dischidia* and their Double Pitchers." 2. Prof. John Percival, "Silver-leaf Disease of Plums." 3. Prof. John Percival, "Observations on the Occurrence of Crystals of Calcium Oxalate in Seedlings of Alsike." (*Trifolium hybridum*, Linn.) 4. Dr. Elliott Smith, "The Morphology of the Cerebral Commissures in the Vertebrata."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. J. L. Baker, "The Action of Ungerminated Barley Diastase on Starch." (Part I.) 2. Mr. W. H. Sodeau, "The Decomposition of Chlorates. Part V. Potassium Chlorate in Presence of Oxides of Manganese."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Spielmann, "Contemporary British Sculpture." (Lecture III.)

FRIDAY, JUNE 6...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Sir Benjamin Baker, "The Nile Reservoir and Dams."

Geologists' Association, University College, W.C., 8 p.m. Papers by Mr. Osborne White and Messrs. M. A. C. Hinton and Gilbert White.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, JUNE 7...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Brander Matthews, "The Development of the English Drama." (Lecture III.) The Drama under Elizabeth.

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FRIDAY, JUNE 6, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's Conversazione will be held, by arrangement with the Council of the Royal Botanic Society, in the Gardens of that Society, Inner Circle, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 o'clock.

Two entrances to the Gardens will be used. The principal entrance faces the road leading to York-gate and St. Marylebone Church. It is less than half-a-mile from Baker-street Station, on the Metropolitan Railway. The second entrance is on the North side of the Gardens, near the road leading to Chester-errace, and the east side of Regent's-park. A covered way leads from this into the Conservatory.

The central portion of the Gardens only will be used. The Gardens will be illuminated with coloured lamps, and also by the Kitson Incandescent Oil Light.

The Conservatory and Club House will be open.

The Royal Botanic Society's Exhibition of Rhododendrons will be on view, and there will be a special exhibition of roses and growing and cut flowers by Messrs. W. Paul and Son of Waltham Cross.

A selection of music will be performed by the String Band of the Royal Artillery in the Conservatory, and by the Band of the Scots Guards in the Gardens, commencing at 9 o'clock. The Red Hungarian Band will also play at intervals in the Gardens and in the Club-house.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards will be forwarded in due course. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets, or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday Evening, May 6, 1902; Carmichael Thomas, Member of the Council, in the chair.

The paper read was—

THE PRINTING OF MODERN ILLUSTRATED OR DECORATED BOOKS.

By Charles T. Jacobi.

Before commencing this paper I wish to make it perfectly clear that it will bear more on the typographical than on the pictorial side of illustrated or decorated books. I will, however, endeavour to show some connection between the two, as it occurs to me in every day practice as a printer. Beautiful books do not always mean those which are illustrated, though some embellishment frequently adds to their beauty.

For me to attempt to deal with the more artistic part of the book I think would be presumption, when I recollect that such exponents of the decorative and graphic arts as

Mr. Walter Crane and Mr. Joseph Pennell have at former meetings of this Society demonstrated their views from their own standpoints.

As my own authority on typography I naturally rely on the traditions of the Chiswick Press, with which I have been associated for many years, and some of my references will be to the work of that press before my connection with it.

In addition to the traditions of the two Charles Whittinghams (uncle and nephew) and William Pickering who did so much good work with the nephew, a study of the researches and opinions of Henry Stevens and Henry Bradshaw, the bibliographers, William Blades, Caxton's biographer, and William Morris, author and artist, has helped me in my work. I am also indebted to Mr. Emery Walker and Mr. Theodore L. de Vinne of New York, for some theories which I have been able to put into practice. If I may at this stage do so, I should like to pay a tribute of respect to Mr. de Vinne. That gentleman has done very much during recent years to raise the standard of printing in America, for he has contributed very largely to the literature of the subject, both in a practical way and from an historical point of view. His work in connection with the Grolier Club will be well known to many here.

Before touching on the main part of my theme—that of type and its employment—it will be necessary to take a cursory survey of the work of the old printers, and also that of some of the private printing presses of the 18th and 19th centuries, including those of the present day.

In the first place we ought to consider what constitutes the artistic properties of a printed book. The three factors are type, paper, and ink, and in the selection of these materials some judgement is required, not only as to their quality, but also that the combination, especially of type and paper, shall be in accord. The next step is to secure a proper *format* for the work, and in this shaping of the volume very much depends on the exact proportion of the type area to that of paper. The question of margin is a most important one, and later on I shall return to that subject. It is this which imparts dignity to a book. The precise proportion of surrounding margin is regulated largely by the size of the book and that of the type employed, although the exact relation of the margins on the four sides of the page should still preserve the same proportion to each other, however the total area may vary. No definite rules can b laid down to govern these details, and that i where the difficulty lies. It is simply a matte of taste or artistic appreciation on the part o the printer or the person responsible for th design of the page.

These essentials to a good book being granted, the next important thing is the prope application by the workman of the materia elements. We hear it said on all sides that the sub-division of labour in any art or craft serves to lower the individual workman's interest in his work, and possibly this is so. Modern requirements, through competition and other causes, have necessitated or rather dictated this, and the only remedy I can suggest, if this division of labour must still exist, is proper supervision—firstly by the principal, and in turn this must be well seconded by the heads of the different departments. Of course, in making these suggestions I have in mind that commercial considerations of the present time have necessitated very large printing houses which have to cater for the general public on utilitarian lines. The smaller presses, private or otherwise, have their own methods, and do not compete with the average printer. Very much work done in a general printing office is of passing moment, but there is no reason why even that class of work should not be done decently and well. After all, it costs no more to do this, because it is purely a matter of style, and if the materials employed are poor, by reason of some limitation of price, much may yet be done in the actual shaping and printing of the book.

Art has been defined as a means to accomplish a desired end, or a method of doing well some special work, that is, the systematic application of knowledge or skill in order to create the beautiful. In turn, beauty has been described as consisting of those qualities which are pleasing to the eye and mind, and is, therefore, synonymous with the elegant, the charming, and the graceful.

If we have these definitions in view we shall keep within reasonable limits. Unfortunately, in the days of machinery and much competition, these essentials are often overlooked, and the general results become intolerable. I do not advocate moving in any one groove, for it would be folly not to avail ourselves of the varied improvements made in the materials and appliances in connection with the printing arts. What is required is the proper use of such improvements, and after that the due exercise of them in the necessary application. If we act on some of the theories employed by our predecessors, and apply some of the modern improvements, we shall not go far wrong, for the early printers' conception of what the form of a printed book should be has never yet been surpassed. Of course I know that there was a certain amount of indifferent work done in the Middle Ages, but we have no occasion to concern ourselves with bad work, and are able to take the result of the "survival of the fittest" as our standard.

A reference to these early printed books, even to the incunabula, teaches us much. Some of those belonging to the second half of the 15th century—the very starting point of printing from movable types—are triumphs of workmanship, and are truly examples of good and thorough printing. We can only wonder how such splendid work could have been produced in those early days.

I do not propose to invite any discussion as to who invented the art of printing—whether it was Coster or Gutenberg—but if we take the 42-line Bible of the latter printer as being one of the earliest, if not the first volume ever printed from movable types, we observe that the arrangement of the type page, the printing, and the ink, are almost as perfect as in any modern book. This book was probably finished in 1455, and though it is nearly four and-a-half centuries old all the copies in existence are in a good or fair condition. Considering the very crude materials and rude implements at command in those days it is wonderful how such work was performed.

These remarks apply also to those early printers, both French and German, who settled in Italy in the following decade, when the printers of Mentz were dispersed. Though foreigners, Sweynheim and Pannartz, and Nicolas Jenson carried the art to Italy, and John of Speyers with his brother, Ratdolt, and subsequently the Alduses fostered and carried on the traditions of printing, and obtained some most remarkable and lasting results. That these should have been produced in the infancy of the art is indeed marvellous.

In all respects, the different points which go to make a good book must have been well considered in those days: the proportion of the printed page to the paper—by that I mean the surrounding margin — the actual presswork, and that too by the clumsy old wooden press. The lustre of the ink used is still preserved, and shames many a modern book in that respect.

Although the invention of printing was not due to Italy, in those early days much was done in that country to improve it, in evidence of which I have already mentioned a few names familiar to all bibliographers. This tradition has, however, not been maintained by that country in recent times, for the merits of the general run of printed books in Italy during the past century are much behind those of France, Germany, or England.

The types which the old Venetian printers employed were really of a very beautiful character, and it is said were based on some of the most perfect specimens of handwriting, both contemporary and of much earlier date, subject to certain modifications which would naturally be suggested, and would in fact be demanded, for the separate characters of printing types. The characteristics of these Roman founts employed were so marked, that one of those employed by Jenson gave Morris—as we shall see later on—his inspiration for the Golden type. He made certain modifications, but in the main his type is admittedly a copy of that master.

Jenson's types apparently have always been considered of a good Roman character, for several printers and type founders of succeeding centuries adopted them as models. This is remarkable for the reason that the fifteenth century was still under the influence of Gothic art, and that element still predominated very much in the work of other printers.

Even in those days the Venetian printers understood the relation of type to illustration, and I need only refer for confirmation of this statement to the celebrated Poliphilus, printed by Aldus at the end of the 15th century, one of the very choicest of the incunabula.

It is especially interesting to trace back the demand for illustrations or graphic decorations. We observe its origin in the illuminated manuscripts of the previous ages and in the block books of the Netherlands which immediately preceded the invention of printing from movable types. We can then follow it through subsequent centuries—from the presses of Italy to the various countries where printing was practised. We observe its rise, progress, and deterioration until the end of the 18th century, when Bewick introduced his methods of engraving on wood. Until that time woodcuts and engraved copper plates both served for pictorial purposes. That of wood was the older form, and such blocks were cut on the longitudinal plank with knives. This method was limited in its application, and although the results were often somewhat crude, its harmonious effect in conjunction with printed type was sometimes admirable. Copper-plate engraving gave more detail, but as the actual printing was a separate and slower process it was less used—besides the expense was greater and the connection between relief and intaglio printing did not always give happy results.

Bewick's method was to engrave with a burin or graver on the end grain of wood, which was quite distinct from mere wood-cutting in plank fashion. His style gave much greater, or at any rate very different, facilities for expression, which was helped by the use of the white line. He created quite a new school of artists and engravers, and such names as Thurston, Clennell, Thompson, and Williams may be mentioned as followers and exponents of this school.

The Plantin Press at Antwerp affords an excellent opportunity of studying the methods of the past, and I would cordially recommend a visit to that most interesting museum. Here will be found examples of the most varied printing, covering the period from 1576 to 1876, executed by Plantin and his successors. A large proportion of the work executed at this famous press was illustrated, but chiefly by the intaglio or copper-plate method. It engaged such famous artists as Rubens and Van Dyck amongst many other masters.

The Elzevirs of Leyden may also be quoted as printers of the 17th century who produced good and tasteful books.

Returning to the period of illuminated manuscripts, one need not go abroad to find examples. In London, at the British Museum, the student can see practically side by side with the earliest productions of the printing presses of Germany, Italy, France, and other countries, some very beautiful manuscripts, and study the relation between script and the printed letter. This evolution was so gradual, especially in the block books, that it is sometimes difficult to decide off-hand if the lettering has been done by hand or whether it was cut and printed as part of the block. Here may be seen Gutenberg's Bible, sometimes called the Mazarin or 42-line Bible, and among other specimens the Mentz Psalter, which was printed by Fust and Schœffer in 1457. This is the first book printed with a date, and it is also of special interest from the fact that it is the first book printed with coloured initial letters.

Returning to later work, the type-faces employed in England during the 17th century were generally good, but the actual printing was very indifferent. Much of the type used at this date, and up to the early 18th century, was imported from the Netherlands, and was largely based on that used by the early Italian printers. An exception was that series of types designed and engraved by William Caslon, which he commenced to cut about 1720. This series was admirably rendered, and was largely in use to the end of that century. Its characteristics were somewhat similar to those of the Dutch founders, but superior in design, and as type it was better finished. Unfortunately fashion again prevailed and the types used generally in the 16th and 17th centuries were allowed to lie dormant and give place to the whims and fancies of certain French and Italian printers of that period. This had a disastrous effect generally on the subsequent books issued from the English printing press, and though Mr. Charles Whittingham, of the Chiswick Press, who died in 1876, revived the use of the old Caslon founts in the early forties, the so-called modern face prevailed very largely, and still does so in certain classes of work. However, his efforts created a demand for a modernised form of old-faced type, and about the date of the Great Exhibition of 1851, Messrs. Miller and Richard, of Edinburgh, commenced to cut their series of old style faces which, for the better class of bookwork, is still largely used. This in turn created other founts based on the revived old style, but they were not always so successful, because to make some difference, the designers were apt to lapse into extravagance.

These exaggerations have been very painfully illustrated by some of the American type-founders in their zeal to produce something different: the striving for the unusual to the detriment of that which should be beautiful.

One may fairly attribute the modern renascence of printing in the middle of the 19th century to the revival of the Caslon type, and the subsequent adoption generally of the modernised form of old-faced founts. This renascence has been considerably emphasized by the influence of the Kelmscott Press in the nineties.

Without doubt, Nicolas Jenson's Roman type was of the purest form, and it is interesting to trace its influence on the various type founders at different dates, French, Dutch, and subsequently English. Garamond, the French founder of the 16th century, copied it, and subsequently the Dutch founders—we observe it in Enschedé's specimen books of the present day—and Bishop Fell's types, which are a specialty of the Oxford University Press, are also of Dutch origin. Caslon was also impressed with the correctness of the Venetian type, and we have seen that Morris and others have gained their inspirations from Jenson, with more or less success.

I will show you, later on, some samples of Roman types which sprang into fashion at the end of the 18th and commencement of the 19th centuries, all of which compare unfavourably with Caslon's. It is also curious to observe that this depreciation applies to some black-letter examples of the same period.

In each case the thickening of the body and the trimming of the finishing strokes are to be specially observed. A really good alphabet is one that does not show such extremes. It should be, as a general rule, not condensed laterally, but fairly broad and quite devoid of all pretensions to flourishes or unnecessary curls or loops to the end of the letters. All undue lengthening of the serif is reprehensible, neither should it be absolutely flat, nor rendered too clumsily.

I will now make some reference to the work of private presses. Baskerville and Horace Walpole did much in the 18th century to redeem the general run of bad printing at that period, and to Baskerville is due the greater credit. I class Baskerville's Press as being a private one, for he was not originally a printer, and his connection with books was an experimental one all through. He lost considerable money over these experiments, which he did not regain until he practically gave up printing and resorted to something else. He designed and made his own type, and printed with his own ink. It is said also, that at one time he even made paper. It is worthy of mention that, previous to his becoming a printer he exercised the profession of a writing master, which would eminently qualify him for designing a new character of type face.

His type faces, if not considered by all to be beautiful, were at least legible, and this is the greater merit if the two are not combined. To my mind, though the general lines of his Roman type are good, and of handsome proportion, he fails in the finish of his letters. The italic he used was too cramped or condensed, and just the opposite to his Roman, which was based almost on a square, taking those letters without tails or upstrokes. At a later period his work had an inspiring effect on some few printers, such as Bensley, Bulmer, Whittingham, Johnson, and, later on, Corrall.

The work of Horace Walpole at the Strawberry Hill Press is well known to collectors. Certainly, for an amateur, some few books out of very many were fairly produced. The larger works were conceived on generous lines as far as the arrangement of the page was concerned; but the press-work was ordinary, and not to be compared with the average of Baskerville's. I have just had an opportunity of inspecting several of the volumes produced at Walpole's Press, a collection having been recently offered for sale, and I was struck with this press-work. Finding it vary somewhat I could only attribute it to the fact that some changes must have been made in the workmen, and that these workpeople were better typesetters than printers. Walpole's edition of Lucan's "Pharsalia" was probably his best work from a typographical point of view.

Coming down to the 19th century, the most famous of the early private presses was that of the Lee Priory Press, which was founded by Sir Egerton Brydges, and which ran for about eleven years. Much of the good work emanating from this particular press was due to John Johnson, the author of Johnson's "Typographia," which is still a classic work on printing for both technical and historical matters. The life of this press was curtailed probably from the fact that Johnson left it and started in business for himself.

Another press that had a long run was that erected at Middle Hill, Worcestershire, about 1822, by Sir Thomas Phillipps, the distinguished antiquary. A good deal was produced from this press, but the printing was of a mediocre character; I mention it because it is interesting to note its long history of about fifty years.

The press of the Rev. C. H. O. Daniels has also had a prolonged and interesting history. One merit attached to this press is that the owner is, I believe, his own executant; but I venture to assert, with all due respect, that his typographical discrimination, which is excellent, is not equalled by the presswork.

In recent years we have had the Kelmscott Press, and its work is already historical. As its praises have been sung by many writers I need not do more than say that William Morris did more in the few years his press was running to influence style in printing than any other printer. We can see his influence not only here, but in America, Germany, and even in

Sweden. This spirit of emulation, however, is somewhat apt to run riot and to overstep the mark in efforts to imitate what may be considered models of good books, both in design and workmanship.

Much is due to the efforts of Mr. C. H. St. John Hornby, both in the *format* and in the actual presswork of his books. This is especially creditable from the fact that the work is entirely performed by Mr. Hornby and members of his family. Up to the present time he has employed the best types he could obtain from the existing founders, including those known as the Fell types.

He has recently had cut for his special use a new fount, which is practically a copy of the types used by the two Germans, Sweynheim and Pannartz, who first settled at Subiaco, near Rome, and were contemporary with Jenson. This new type has a suspicion of the Gothic in it, which, on the whole, is pretty, its difference being quite marked from that of Morris's, or from any other special fount which has been designed lately. My only criticism is that it may be considered by some authorities to be somewhat too condensed laterally.

That employed by the Vale Press is admittedly not unlike the Kelmscott Press Golden type in general appearance, save for some few eccentricities which I do not care for myself; but the general get-up and average results, are, I think, very good.

Lastly, and not least, I would mention the Doves Press. I think its Roman fount is all that can be desired, probably better than anything ever before attempted. I consider that not only is it agreeable to the eye, but it is particularly readable, whilst the actual press work, so far, has been admirable. True, there are a few little innovations in the design of the type, but the whole effect is good. What strikes one in looking at a volume produced from this press is the perfect alignment of the letters; but this may be considered by some as giving too mechanical an effect.

The productions of most of the private printing presses of the present time must, on the whole, be commended, for the books issued therefrom have created a demand for better things, and through that, given a stimulus to the ordinary printers. This has been the means of considerably improving the average class of book printing, but, at the same time, it must be confessed that it has had the usual effect of producing some examples that are hopelessly bad, and exaggerated in form and in execution too. Sometimes the spirit was caught, but the conception fell short in its execution. Unfortunately, there are many travesties of Morris's style. His type was appropriated with varying success, but most of the attempts to imitate his ornament or decoration were dismal failures, unless they happened to be a direct piracy of any particular piece or set, and they too often were badly reproduced

We must now consider the making of a book and it is a fact that, unless the foundation is good, the structure will, as a result, be bad. This analogy between printing and architecture was sometimes alluded to by Morris in his essays on printing, and if we go further back we find Moxon, who, in his "Mechanick Exercises," 1683, differentiated between the mere printer and the typographer, saying, "I find that a typographer ought to be equally qualified with all the sciences that become an architect." With a definite object in view and given the proper materials, a competent workman should be able to produce what Henry Stevens used to term a "comely book."

The choice of type is often limited by the conditions that a volume must be kept within a certain compass, but if no such restrictions hamper one, it is advisable to select as large a face as is reasonable. Legibility should be the very first consideration, and this may be arrived at by using a large face of type, and printing in a good black ink with a firm impression on a suitable paper. Bad ink and weak impression are just as fatal to the appearance of a book as an insignificant type —in fact, it is quite possible to improve the latter by employing good ink and obtaining a firm impression.

For legibility, I would commend the *Monthly Review* as a good specimen of type where comfort in reading is desired. This question of legibility should apply equally to newspapers, but, unfortunately, the bulk lack that essential.

It was said by Morris and Emery Walker, in their joint essay on Printing, published by the Arts and Crafts Society, that it costs no more to print a beautiful type than it does an ugly one. This is quite true, but the difficulty is always to find the beautiful. Legibility may combine both beauty and clearness, but if the first element is sometimes lacking, there is no limit to such types as have the advantage of being both clear and readable. By all means secure the two, if they are to be obtained.

This theory of legibility I would also like to see applied generally, for not only does the absence of it affect the ordinary reader, but it very seriously handicaps the rising generation whilst undergoing the necessary educational course. If scholastic books could be printed in larger ype, there would be no necessity for the London School Board to appoint oculists to examine he eyes of the scholars.

One instance I call to mind on the subject of the decline in legibility of type, is that of the three volume novel. That particular form of literature was in some respects an advantage. In order to spin the work out to its orthodox length a large type had to be employed, and, if it was not always handsome, it had at least the merit of being readable from the fact that it was fairly large and comfortably leaded. I think we all appreciate such printing when we sit down to read a book. The six shilling novel of the present day is issued in one volume only, and the size of its type has often to be cramped to keep it within that limit.

The use of very small type, except for special purposes, should be made penal.

The subject of newspaper printing is one that might also be well considered by the Society of Arts, which has instituted committees, and issued reports on the present day paper used, and also on the leather used for binding purposes. Why not one on type? It would surely be the means of doing some good for the general community.

What is more trying than to attempt the reading of our daily paper as we come to town? Sooner or later this does have a detrimental effect on the eyesight, and if we can obviate the use of artificial aids, or at any rate, postpone it for a time, it would be for the general good.

The existing craze for advertising has undoubtedly pandered to the very vulgar taste often displayed in typographic matters. The grossest absurdities in the way of bad lettering are put to this purpose, and to come across a well displayed advertisement in simple and consistent characters of type is the exception rather than the rule.

The precise choice of a type fount as regards the face should be governed by the class of work for which it is required. The more severe form of old face, such as Caslon's, is admirably adapted for works of an antiquarian character, whilst the more modern character of old style may be used almost for anything; but, as these types are somewhat thin and wiry in structure, it is needful to print them somewhat strongly. The more modern face founts, of which there are a great many varieties, some worse than others, may be employed for the ordinary class of work. The bulk of these founts are usually stronger in face as a mass, but it is the actual design or finish of the letters that is so often bad.

Two things which considerably affect printed matter are "leading" and "spacing." Lines are spaced out in depth by the use of leads, and the intervals placed between the words laterally are expressed simply by the term "spacing."

As an apprentice, I was taught that spacing should be regulated according to the width of line, whether the matter was leaded or solid. Very close or wide spacing are both objectionable. The first is confusing to the eyesight, and the words seem to run into one another; whilst the second is apt to induce a sort of jerkiness in reading, that is, jumping from one word to another, and has the effect of what we printers call "pigeon holes" of white.

Wide spacing tends to disintegrate the solidity of the whole page. Sometimes a yawning gap is observed down the middle or side of a page, or what has sometimes been termed by authorities a "river of white" flowing down the page. This can be obviated, although it is very troublesome in narrow widths of type.

As a general rule narrow widths in type setting do not require the lines to be spaced out by the use of leads, but the same type that would look well set solid, *i.e.*, without leads, in narrow measures, would require to be spaced out with leads if printed in long or wide measures. This assists the eye in taking up the continuity of the lines. If the page is a large one solid matter is best in columns—not running across the whole width of the page.

As an instance I would refer anyone to the "Pall Mall Magazine" of the present time. Formerly it was printed in the full width of the page, which made it somewhat difficult to read, but lately it has been printed in two columns, which renders it much more comfortable to read. This comparison applies also to book printing.

Margins should be arranged so that the greater proportion will fall on the fore-edge and on the tail or foot, especially on the latter. We find this so in the illuminated manuscripts and in the early printed books. In the books printed for William Pickering in the middle of the last century a feature was made of these points, as likewise in those books which were printed for Henry Stevens.

The notion that the two facing pages of the open book should be taken as the unit is perhaps one explanation of the reason; but there are many others that may be advanced in support of the practice. One would be that in the old MSS. the greater margins would be adapted for decoration such as borders or other designs of any ornamental character, which often overflowed into the margin. Another is that the extra width at the side served for annotations or marginal notes. Besides, the deeper margin at foot permitted the book to be handled without obscuring the reading matter, and in the event of a book being re-bound, which does happen sometimes, those two edges which have been subjected to the most wear and tear have enough to spare should it be necessary to trim them to make them tidy.

These margins are, in some few cases, perhaps, too exaggerated. To arrive at some sense of proportion is not a rule of thumb, but one must be guided by the size of type employed and the size of the page. Books of a large size, such as a quarto, demand more margin than an octavo. This considered, the next thing is to adopt a type area which will bear some relation to that of the paper, and the united margins of tail and head should be more than those of the back and fore-edge combined, so as to allow the greater depth at foot. The smallest margin should be in the back of the book, so that when the volume lies open there would be some sense of connection between the two facing pages. In fine books, the double margin between these two pages should be, roughly, equal to the fore-edge, so that the three parallel margins are practically the same. The head margin is best with a trifle more than the back, and that on the tail should be the largest of all.

Taking, for instance, the total area of a crown 8vo page (which measures in height 7½ by 5 inches wide), a fair proportion, as regards width, would be about one-third margin to about two-thirds print, but in height the proportion of margin should be slightly more.

If one were to take a book in which the margins have been so arranged that the print falls in the dead centre of the paper, it would be apparent that something was wrong, and even though the margin was equal all round, the general effect would be that the top had more than the foot, and the back more than the fore-edge. This alone should persuade the most inexperienced that it is necessary to increase the outer and bottom margins in order to counteract this effect. I ask you to compare any two books printed with the different kinds of margins now specified.

The effect of margin is just now being admirably demonstrated to the "man in the street" on the London County Council hoardings in the Strand hard by the new streets now being formed. The innovation is certainly a good one, and should be an object-lesson, for it shows that a surrounding margin will improve even a huge broadside.

It is worth while to remark at this point that the printing of posters has improved in a general way during the last few years, and some really good broadsides are occasionally to be seen—one of a decorative character was that of the London School Board during the past two sessions announcing the Continuation Schools. Possibly the fashion for the collection of such things gave an impetus to broadside printing, just as it did to bookplates when that cult came into vogue.

The question of paper is also very important, and one which this Society has already set itself the task of investigating. For durability that made by hand is the best, but this kind is not used for the average illustrated book, especially that in which the half-tone process is adopted. Paper which is made exclusively of linen and treated with animal size should stand the test of time, but one cannot answer for the cheaper kinds of hand-made papers. For an *édition-de-luxe* the question of paper need not be considered very much, because in a limited number of copies the total cost is no large amount, and such editions usually command their price. Certain illustrated works may be printed on these hand-made papers, but the illustrations must be of a purely outline character in order to print clearly and sharply. Designs of decorative character are suitable, and one need only refer once more to some of the Kelmscott Press volumes to see with what degree of success such designs have been printed.

Many of the machine-made papers of the present day are mere shoddy, and it is seldom possible to obtain from stock a decent all-rag printing paper. Such a paper can be made by a few special mills, but I feel very dubious about some of these so-called rag-papers being made exclusively of that material.

In the machine variety many kinds exist, and a good many of these are to be shunned at once if the durability of the book is to be studied. Half-tone block work demands an absolutely smooth surface, which is an unnatural one, and is only obtained by unduly rolling or calendering, or even coating the surface with some foreign substance, usually of a mineral nature. Either kind is objectionable, but especially the latter.

The best half-tone process blocks from a pictorial point of view are those produced by the use of the finest possible screen. This screen, or almost imperceptible network, is employed in photographing to break up the surface, as it were, in order to impart the necessary medium for varying tones or shades of the picture. To obtain the best results in printing from these blocks it is necessary to print on an absolutely smooth paper, in fact, the higher the surface the better the printing is brought out.

So far, no way out of the difficulty has been discovered. Type on this class of paper looks poor and weak, and it is best, if possible, to give half-tone blocks a different treatment from that of the text: that is, to make separate plates of these illustrations; and if they happen to be of a small kind, group them together to form distinct pages. These can be printed on the necessary but objectionable paper, and the text on a more natural one.

Perhaps a solution of this difficulty will be found in some after-treatment of the sheets when printed, and some experiments which I have made in this direction have been fairly successful, but I am trying at present to develop a more simple way which will rid us of the obnoxious features of this paper.

These loaded or mineral-coated papers have some other bad features, and one particularly is that of weight. If we take any two books of the same bulk and size, one being printed on this so-called art paper and another on ordinary paper, especially that of an antique laid character, an extraordinary difference is observed in the weight. Unfortunately, this is not all, for the glare and shininess is bad for the eyesight, and even the mere handling is objectionable.

Besides this, there is the perpetual anxiety for the ultimate condition of this kind of paper, because we well know that the artificial facing is of a perishable nature and must sooner or later decay and possibly become discoloured.

With regard to presswork, this is a general term for printing off whether by hand or by power. The hand press has done wonders in its time, but the power press has spoiled the hand pressman, for he would sooner be a "machine-minder."

I am no conservative in this respect, for it is no secret that the old painstaking pressman is practically extinct, and if a lad is apprenticed to a firm where both methods are employed he counts the days and months that must elapse before he can "mind a machine." All good work was done by hand at one period, for the reason that there was no alternative; but there is no need for the general printing office to cling to old methods, for printing machinery has so vastly improved nowadays that equal results can be obtained, provided the workman is intelligent. In fact, it is possible to do all that modern conditions require on a power machine, and, on the other hand, it would not be possible to obtain everything from the hand press, even if the men could be found to undertake it. This applies particularly to the printing of books illustrated with half-tone blocks. For small offices or private presses the hand-press serves admirably, and will do all that is required.

I well recollect the late Gleeson White, in a paper which he read on "Drawing for Process Reproduction" before this Society some few years ago, remarking that modern printing had come to stay, and that its conditions forbade a return to the more archaic methods. This opinion I cordially endorse, but what I consider is necessary is for us to adhere to some of those principles which our predecessors laid down, and to avail ourselves of modern methods in their application. The conditions of our time demand this, and what we have to do is to create fresh standards without being slavishly influenced by any definite or dogmatic canons. A reference, however, to the old masters of printing will certainly help us to formulate and set up new ideals. But to do this it is imperative that the co-operation of author, publisher, printer, and bookbinder be obtained. This was insisted on by Henry Stevens in his little pamphlet, "Who spoils our New English Books?"

The treatment accorded to the making-ready or preparation for the printing of wood-cut blocks and of those made by process is quite different, especially for those by the half-tone method. Formerly the degrees of light and shade were obtained from the woodcut by lowering the block in certain places where light effects were desired, and the solids were left standing in the original height. We have the authority of Papillon, the French authority of the 18th century, for this. With the introduction of engraved wood blocks, another method had to be employed in order to secure the different degrees of tone, and these gradations were brought out by overlaying with various layers of very thin paper cut to the required size and shape. This was first assisted, where necessary, by underlaying the block itself. This having been done, the overlays are made from say three pulls taken on a fairly hard paper; the light or high tints being cut out in the first case, and in the second and third pulls the medium tones and solids would be also cut out, and such pieces then affixed respectively to the first one. By these means the full results of light and shade are obtained when this overlay is put into the exact position. It is of course necessary that the workman should have some artistic appreciation before a good result is obtained.

With half-tone illustrations quite another method must be employed. It is absolutely necessary that the block be very truly underlayed, in order to bring it up to the exact type level—some prefer a trifle higher—and also that it be equally level at the four corners, without any rocking on its base of wood or metal. This having been done satisfactorily, little or no overlay is required for the proper printing of these illustrations. Given the proper ink and paper, with a hard and sharp impression, this is all that is necessary. Any drag or slur on the impact of the printing surface with the impression cylinder of the machine is most detrimental to the finished print.

I have referred to the beauty and depth of "colour" of the black ink used by some of the old masters. The printer formerly made his own ink, and he was a wise man in his own generation. Now-a-days the modern printer buys all his ink, and as a rule the secret of what was called "the art and mystery" of printing lies very largely in the ink. In these days of chemicals one hardly knows how inks are made, because they have to be adapted to the modern requirements of shining paper and process blocks, and what are considered full or good effects are only arrived at by the use of some stimulant, usually a chemical or mineral, and then one never knows the ultimate result. I have seen, by the use of improper inks, some very alarming results.

For good paper, whether handmade or otherwise, it is essential that a fine carbon ink be used. Any so-called bloom or sheen is usually obtained by the use of a metallic or other substance which is sure sooner or later to develop some chemical action. For plain type printing a perfectly pure pigment must be used, but, unfortunately, for the satisfactory working of half-tone blocks the ink has to be very considerably doctored for fast running machines. A comparison of the bulk of impressions with the engraver's proof is not always a fair one, because an ink giving good results for single proofs would be quite unworkable on a machine that may only be running at an average rate.

A good deal has been written and said about the "sixties" in the annals of illustration. In some respects I think the glamour connected with this period is not always deserved. True there were many capable artists and many came to the front. Much of the work was well designed, but it was not always well engraved—at least, that is my opinion—and some of it would have been better if it could have been processed, which of course was not possible at that date. Having ventured this opinion, I will go further and say that very many of the books of that period were anything but the "fine art books" they profess to be. I say this to the detriment of my own craft, for I cannot help thinking that with proper consideration the general get-up of many of these volumes could have been better designed, and, what is more, better printed.

In surveying the English illustrated book of the first half of the 19th century—that is, from the time of Bewick up to the sixties—I find that a great many books of representative character emanated from the Chiswick Press. These books are both of pictorial and decorative character, and many were done in conjunction with William Pickering, the publisher, who died in 1854. The shape and form of these books was only arrived at after a great deal of deliberation and experiments. This the late Henry Stevens tells us in his little *brochure* already mentioned, which I would advise all to read, for it will be to their advantage. In this little work he respectively applied the lash to the author, publisher, printer, and binder, and much of his trenchant criticism was deserved.

To render full justice to the new school of engraving, it was necessary to employ special methods in printing, and it is a tradition of the Chiswick Press, that overlays, the use of which has already been explained, were first used in that establishment, though I have read of a French claim to that innovation. At any rate, Mr. Whittingham was one of the first to practise overlaying, and to bring it to perfection, so much so, that it is said that Bewick was fairly delighted with his treatment of wood engravings in printing. Mr. Whittingham's tombstone in Chiswick Church, records hat he "attained considerable eminence in his rt, particularly in the printing of wood engraving."

We must all regret the decline of wood ngraving, for, in connection with type printing, t was the true method of illustration. It was apable of giving much decorative expression hat can scarcely be hoped for in any mechanical process. It is, however, some consolation to now that methods of reproduction have improved so much that it is possible, with a due regard to the altered circumstances, to obtain good substitutes for hand-engraved work. In some cases, facsimile line work may be even better rendered by process. If we wish to see how far process has succeeded, we have only to refer to the reproductions of the work of two such very different artists as Mr. Hugh Thomson and the late Aubrey Beardsley. Here are the two extremes of method in drawing.

In dealing with process work, I propose only to consider such blocks as can be printed with type, and not the other methods which require quite a distinct and separate treatment in printing—such processes falling under the heads of photogravure, lithography, or those using gelatinous films.

The closing years of the 19th century saw the rise of process work, which created the almost universal demand for illustrated literature that could be both expeditiously and cheaply produced by the various methods in vogue. Photography does not lie, though it may distort, therefore I consider that there is no degradation in the reproduction by mechanical means of drawings in line.

When we consider this advantage, and the fact that any block for printing purposes can be produced quickly, and at a nominal expense, it is easy to account for the great demand for blocks mechanically produced.

In former times the artist was somewhat at the mercy of the engraver, for, whether the original picture was drawn on the wood direct or photographed thereon, as was the custom in the latter part of the century just closed, everything depended on the engraver—for it was he who gave the expression or interpretation to the artist's work.

It is true that artists were sometimes engravers too, but such cases were rare. Naturally, some of the very best examples of wood engraving extant are those which were both drawn and engraved by the same individual.

With regard to the blocks executed by the half-tone method, which reproduce surfaces rather than thin lines, either direct from nature—that is, from a photograph taken direct from an object, or from drawings made in wash—there is room for difference of opinion. Without doubt, there is not the artistic merit in these productions that may be found in the other process, but I think we shall all agree that this method has greatly improved during the past few years, and that the high-water mark of excellence has been very nearly reached. The results, so far, are mechanically very ingenious and most marvellous, even if we do not think the general effect artistic.

Such blocks are very much improved if afterwards engraved on by hand, as in the case of many of the illustrations appearing in some of the American magazines, but this requires much practice and considerable feeling if it is attempted, otherwise the labour is in vain. Vignetting of half-tone work is a thing that our cousins seem to have brought to greater perfection than we have.

It is necessary, in considering picture-books, to discriminate between those illustrated from a pictorial or graphic point of view, and those of a purely decorative character. Sometimes we have books where a combination of the two motives is attempted, but often without much success. Some works, owing to the nature of the subject, require illustration, but if pure decoration is aimed at, it should be either thoroughly well done or left alone. In a plainly printed letterpress book there is scope for intelligent work, and it does not always require embellishment to make it what might be considered an artistic production.

Much of the work offered as decorative is overdone, and not always in accord with the typographical setting of the page. Ornament should be sparingly used, and subordinated to the text, and not made to swamp the letterpress. In decoration, designers occasionally forget that the object is to fill a blank space, not to create one; and, on the other hand, pictorial or graphic art is usually secondary to letterpress, because it serves to elucidate or illustrate the text. Some will go out of their way to improvise an opening for their extravagant fancies. If one of two facing pages is short, it obviously requires something to preserve the balance, and here is the opportunity for the artist.

Absolute harmony does not exist between type and illustration, but it is quite possible to reconcile the two with some degree of success, provided due care be exercised.

Truly decorated books are those executed throughout by the same hand, such as William Blake's, the illustration and lettering being woven as it were into one design, but commercial considerations will not allow of this, therefore the artist and printer must help each other. Type letters, as a rule, are conventional in form, so the selection of a proper fount, and one of a suitable size, requires some amount of judgment.

Again, many of the typographical flower ornaments employed by the 17th and 18th century printers were in keeping with prevailing types of those periods, if consistently used. Gothic ornament should go with black-letter type, and designs of a linear character with Roman type. I propose to show you on the screen some slides which will demonstrate these simple facts.

It would be out of place for a printer to criticise artists' work, but I venture to say that the draughtsman may often do much to produce a good effect by adapting his line, as far as possible, to the strength of the letterpress.

In printing any work with mechanical reproductions, we are limited to two kinds of blocks in relief, viz., line and half-tone. These can both be used as textual cuts or as full-page illustrations, either separately or backed with type. Separate plates are not, however, limited to these two kinds, but photogravure, lithography, or the various gelatine processes, such as Collotype, may be employed. It is this mixture of these processes that I object to, and it should be generally deprecated.

The adoption of many processes in any one volume is sometimes made worse by the use of a different paper for each kind of picture, with the result that the volume appears to be a mere sample book of papers and processes.

One other thing to be avoided, if possible, is the interspersing of plates on smooth paper with text on a roughish paper. This may sometimes be prevented by relegating the plates to the end of the volume, thus dividing into two sections of (*a*) letter-press, and (*b*) illustrations.

Referring to those smaller blocks which fall in the letterpress page, designated as textual cuts to distinguish them from those occupying full pages, from a decorative point of view rectangular blocks are better than those of an irregular or vignetted shape. It is not satisfactory to see half-tone blocks made so that they run into the text in any shape, stepped in and out in fantastic forms, with the letterpress straggling all over the page, so that it is confusing to read. Th illustrations should be kept within bounds possible; that is, within the limit of the typ area. For the sake of symmetry, full pag blocks should be of the same size as the letter press page. If a medium size of block, let be the precise width if possible. If a sma one, it is best to corner it or place it at the sid rather than to let it fall in the centre of the typ measure or width; this will obviate the matte being set in short lines on either side of th block. To have the letter-press broken u into so many small lines is very distractin to the reader, and it creates that eyesore o wide or bad spacing which has already bee mentioned.

One other thing to be avoided is th encroachment of ordinary illustrations on th margin, because this destroys the symmetry o the page and the proper balance of the tw open or facing pages. This does not, however apply to systematic decoration, because anything in the way of a border may enhance th beauty of the page.

The placing of illustrations in book work is a very important matter—this being rendered more difficult if the volume is of small size. It is necessary that some consideration be made of the nature and size of the type employed. All this has an effect on the proportion of space between block and matter when the position has been determined. If we take a dozen various books of illustrated or decorative character we shall probably find as many varieties in treatment. No definite rules can be laid down: much must be left to the judgement of the printer, if not dictated by the editor or author.

One other point is the treatment of the necessary lettering or titles to those pictures. These vary a great deal, and one rule will not apply to all. If possible they should be dispensed with, but if they must be tolerated let these under-lines be dealt with in some intelligent way. If consisting of a short title of one line only they can be thrown into the white space or margin, but if occupying more than one line they must be treated as part of the picture and allowed for, considering the space at command. Whether these letterings should be placed in the centre under the block, or range at the side of the block, is only a detail. A definite reason rather than rule of thumb should prevail.

One reason for the inharmonious appearance of books is that they are frequently put into hand before one has any notion of what is to come in the nature of MS., or the extent of the same. If it happens to be a volume that is to be illustrated, no very defined notions are arrived at, but the MS. is flung to the printer with instructions to proceed in such and such a manner. The style of illustration may not be settled, or even the method of producing the same, and chaos is the result!

The making of books of various odd sizes is not a commendable practice, for it savours of eccentricity, and it complicates the classification or description of the books. There are certain standard sizes of books, and, unless there is some definite reason, I think those standard sizes are sufficient. The inclusion of odd sizes is a great trouble to bibliographers, apart from the question of shelf room. Certain rules are current for the identification of 4tos from 8vos, and 8vos from 16mos, but I think the present day variety would puzzle the cleverest librarian when he comes to catalogue his treasures.

The modern printer has much in his favour, and should be able to produce really good work—given the time in which to do it. The selection of book-printing founts is now greater than ever. Printing machinery, too, has very greatly improved during the closing years of the last century, so that the opportunity of doing good work is almost unlimited, provided the printer has the necessary taste and experience, and is not hampered with conditions. That these essentials are necessary, I think you will agree.

DISCUSSION.

Mr. JOHN LEIGHTON referred to the fact that in 1847 the new series of the Transactions of the Society of Arts was in Caslon's type and was printed at Whittingham's, while the first book with which he had anything to do was printed at Chiswick and was in Caslon's type. Mr. Jacobi had spoken of the Plantin Museum and the Plantin type. The latter was excellent, and was like Caslon's. The illustrations, however, of the Plantin books were all copper plate. He had brought with him that evening a page from Rogers's "Italy," with a beautiful illustration of Turner's from a metal plate and a similar illustration printed from a block. The latter had been brought about through the effort of producing things cheaply. At the same time it was done so as to look as much like Turner as possible. As to the French type used in the Imprimerie Nationale the down strokes were heavy, while the serifs were as light as possible. Referring again to Caslon type, he could not help admiring its beauty. He must say that he had had the pleasure of knowing a Caslon. The youngest member of the family died some fifty years ago. An interesting book which he had had to do with was one published by Longmans, entitled "The Life of Man." In that were to be seen every kind of type, every author's life being printed in the type of his period. One curious thing about the origin of type was that the capitals were copied from stone cuttings—in fact, the marks of the chisel could be traced—while the lower case owed its origin to the pen. The Assyrian letter was wholly stone cut, and so also was the Roman. The black letter, however, had a flourish of the pen, which was distinctly visible.

Mr. JOHN SOUTHWARD said Mr. Jacobi had given a very able survey or exposition of what characterised excellence in books. One thing he would have liked to hear more about, and that was the subject of process blocks in illustrated books and papers, as well as the different kinds of paper used. Printers had much cause for complaint in the backwardness of papermakers in supplying a paper adapted to the modern processes of illustration. He was afraid there was a falling off in the general standard of printing to be found in illustrated books. If they looked at a great journal, such as the *Graphic*, it would be found that the early numbers were entirely illustrated by wood engravings. Later on, those engravings were superseded by process blocks. At the present day the printing of the *Graphic* was really a magnificent specimen of art, but that had been attained of course only by the possession of almost unlimited resources, and by having presses of the finest description obtainable, adapted exactly to the particular class of work, while only the very best materials were employed. But the ordinary printer, he regretted to say, had the greatest difficulty in printing process blocks as they ought to be printed, simply because the papermakers had not properly responded to the growing needs. Some fifty years ago when Thomas Curson Hansard's "Typographia" was published, he showed specimens of wood engravings, which he said were superior to any wood engravings that had previously been produced. At that time the papermakers were not equal to supplying a paper that would print the blocks with proper effect, so that Hansard had to fall back upon the plan of using a wretched yellow-coated paper. The other day he was looking at some beautiful specimens of printing from the Chiswick Press in Mr. Marston's "Sketches of the Old Booksellers." The illustrations were from process blocks. It had been necessary, however, not to print them with the text but upon separate smooth paper. Just as, a good many years ago, the books were illustrated by copperplates in the same way. It was really a great pity that they were not supplied with a satisfactory paper. It was not harmonious to use another paper for the blocks simply because they were process blocks. If what he had said on this subject should get to the ears of papermakers, he hoped they would understand that there was general discontent prevalent amongst printers on the ground that the papermakers had not risen to the needs of the recent progress of the printing art; more especially in regard to the new methods of illustration.

Mr. E. ALMACK said on a previous occasion, when the subject of binding was before the Society, he remarked upon the fact that centuries ago such good bindings were produced that even to-day they were found to be in magnificent condition; whereas some of the bindings produced at the present time would not last for twelve months. He happened to possess William Morris's own copy of the first book printed in Nuremberg. That book, printed in 1470, had all the splendid qualities of artistic arrangement both with regard to type and margin. In regard to the paper, the printing, and everything else, it was in a magnificent condition, and was infinitely superior to nineteen twentieths of the books produced within the last 200 years. In some countries on the continent valuable serious works could be sold in thousands, whereas perhaps a book equally good on the same subject if brought out in London the publishers could not sell more than several hundreds of them. Meetings like the present, therefore, he thought would be of great use in assisting them in the desired direction, and not least in encouraging serious study.

Mr. WALTER BOUTALL said he was much interested in Mr. Southward's remarks about the quality and fitness of paper produced nowadays, for he (Mr. Boutall) happened to be one of those sinners of whom Mr. Southward spoke, namely process engravers, who undoubtedly were responsible for a good many of the difficulties which printers now encountered. There was this much to be said of the process engraver, however, that he was a recent addition to the ranks of the kindred trades to the printer's, and had largely influenced the destiny of modern printing. Unquestionably, the necessity for good presswork in the printing of half-toned, or any process blocks, had had a good deal to do with the revival of interest, on the part of printers, in their own craft. In the early days of process engraving, a very celebrated London printer discussed the question with him. Even then he was good enough to say that the process engravers had already accomplished a great deal in the direction of bringing the printer up to the mark, and that he was called upon to print things which, if they had been tendered him five years previously, would have been the means of the process engraver being turned out of the place for being too presumptuous. As to the quality of the paper, he quite agreed that a great deal had to be expected in that direction. Nobody was really satisfied with the kind of paper used for the printing of process blocks. As Mr. Jacobi had pointed out, there were only two alternatives in front of them; they could either use linen paper, thoroughly well treated, or they must have recourse to the obnoxious coated paper. The latter had drawbacks in the way of want of durability, while another disadvantage fatal to its continual use, was the difficulty of handling. A book composed of rag-manufactured paper could be handled with impunity, but if it contained coated papers it must be handled with the utmost care, otherwise the paper would break, the surface would disappear, and with the surface the picture or type upon it. The papermaker had a good deal to answer for in that respect, and a very great thing would be accomplished if they could arouse in his mind the same interest in the quality of the paper that the process engraver had aroused on the part of the printer. Another sinner who ought to be referred to was the ink maker. No doubt he could produce much better pigment and superior material than he offered now. Certainly some improvements had been made, by reason of the efforts of foreign makers, notably the Germans. The English makers, however, still lagged behind, and certain it was that they would have to arouse themselves and do a great deal in seconding the efforts of the papermakers. The author of the paper had admitted there was room for great catholicity of taste, and that the end and aim of modern printing was not necessarily the revival of mediæval printing, but to keep pace with modern needs, and employ all the modern resources at their disposal.

Mr. H. B. WHEATLEY said they had been privileged to hear an admirable *résumé* of valuable hints upon the proper principles for the printing of books by one having great experience in the production of beautiful specimens of printing. In criticising some of the many interesting points of the paper, it did not appear to him at all wonderful to find such perfection in early printing. Printing was an imitative art—it had only to copy the succession of many hundreds of years in the production of beautiful written books. Therefore, he did not think it at all remarkable that when movable types were introduced beautiful work was at once produced. A point to be considered in connection with early times was that taste was largely confined to the few; and the great difficulty now was how the multitude were to be taught true taste. When anything good was placed before the public they usually appreciated it, but, unfortunately, they often seemed to appreciate bad taste almost as highly. With regard to some of the producers of fine books which were held in honour, he did not think Mr. Jacobi quite did justice to Baskerville. In his opinion the Baskerville page was one of the most beautiful that had ever been produced. One of the chief charms of the type was that it was particularly clean cut and more like engraving than print, which probably was partly owing to the fact that Baskerville in his early years engraved tombstones. With reference to the Strawberry Hill Press, he thought they must all appreciate the printing of the standard works which were produced by Horace Walpole. There were a great number of fugitive pieces printed with which very little trouble was taken. With regard to

Walpole having found fault with his workmen, that only took place in the first few years of the press, and when Kirgate came to him he was well satisfied. On the whole he considered the standard of the books printed at the Strawberry Hill Press was satisfactory. Of course the products of the Middle Hill Press did not take rank as finely printed works. Sir Thomas Phillipps was one of the most ardent collectors of manuscripts, and was much interested in preserving them. He printed his catalogues and extracts in the most inexpensive manner, and as far as he (Mr. Wheatley) knew no book published by Phillipps could be considered as a specimen of fine printing. With regard to the Kelmscott Press, all must highly appreciate William Morris's publications. They formed a grand series, produced in the most perfect taste; but at the same time the type was too archaic for common use. Mr. Emery Walker, who had done so much for the Kelmscott Press, was doing a great deal in respect to the revival of good types. Unfortunately some of the projects of new firms founded in consequence of the success of the Kelmscott Press exhibited little beauty, but rather a decided leaning to the grotesque, which was certainly most objectionable. Legibility, as Mr. Jacobi had said, was most essential. As to the size of the type which ought to be used, he thought that was really a question between young eyes and old eyes. If too large a type was used one was inclined to fancy that it was "fatted" out, and that the printer was making the most of his material. On the subject of title-pages, he thought the English people were very much behind the French. Very few good title-pages were found in this country. In France there were many very delightful ones. Most of the good title-pages in English books he thought emanated from the Chiswick Press, and certainly the books published by William Pickering showed as beautiful title-pages as could be found anywhere. As to what Mr. Jacobi said respecting adaptation to modern circumstances, he thought we must take advantage of all modern inventions, and not return to archaic methods. Touching upon illustration, the most important aims of the printer should be to obtain harmony between the type and the illustrations, and to see that only one style of illustration was adopted in each book.

The CHAIRMAN felt sure that all had listened to the paper with the greatest interest. It showed that Mr. Jacobi possessed not only a very wide knowledge of book production in the good old times, but he was also a very competent authority in the present day. He used the words "good old times," because he regretted to say that the use of engraving as a means of book illustration had almost ceased to exist, and, however useful the half-tone process blocks might be to the illustrated papers, and for the purpose of reproducing photographs, there was still a charm and brilliancy about the good old woodcuts which had never been surpassed. Publishers had the reputation of having killed wood engraving because it was cheaper, but they must also remember that artists had welcomed with open arms the advent of "process." Curiously enough although they might not appreciate wood engraving for representing their own work, they were very ready to admit its great advantages for reproducing the work of other artists. He agreed with Mr. Jacobi that in an artistically produced book, with well proportioned margins, printed on rough paper, with good type, that an interleaved illustration on highly coated paper did not harmonise with the general effect: but, at the same time, what could be more satisfactory than suitably chosen subjects reproduced by half-tone process and printed on enamel paper, when issued in such a form as the admirable views of ancestral homes published in "Country Life." In conclusion, the Chairman moved a vote of thanks to Mr. Jacobi, through whose interesting paper he felt sure they would be interested more than ever in their own book shelves.

Mr. JACOBI, in reply, said he was much obliged for the vote of thanks which had been awarded him, and hoped he would be forgiven for the long paper which he had read. There were two names that he had omitted to mention, namely, Mr. Joseph Cundall and Sir Henry Cole, both of whom in the middle of the 19th century had produced some very beautiful books. Referring to the remarks of Mr. Leighton, he was glad to hear of the little link with the past in connection with the old Chiswick Press, and what he had said about the Caslon type. He believed that there were no Caslons in the business now, but that the firm was carried on under that name. Mr. Southward had been very complimentary to the Chiswick Press, and he thanked him. He agreed with Mr. Southward in regard to process blocks. Touching binding, what Mr. Almack said applied equally to printing. There were many splendid bindings that dated back hundreds of years which at the present period were found to be in much better condition than those of modern times. Respecting process blocks, especially those of half-tone character, some printers could not manage to get on with them, and the result was that they put the blame on to the block maker. The Chairman had spoken about "Country Life." For half-tone work it was one of the best examples that could be found. That opinion, of course, applied only to magazine work, and not to book work. Mr. Boutall referred to taking the middle course in printing. He (Mr. Jacobi) was very strongly of Mr. Boutall's opinion, although at the present time competition and every-day demands had altered circumstances. One must not stick entirely to the old rut. Printers need to avail themselves of modern inventions and improvements, and to move with the times. It must be borne in mind that printing offices were not carried on altogether for sentiment, but they were run for the purpose of obtaining a livelihood. Mr. Wheatley referred to the influence of manuscript on printing. That was so, for the early printers found certain standards already set up for them, and this had been acknowledged that evening. When they came to consider the very laborious work in connection with the illumination of books and the cutting of block-books, they must arrive at the conclusion that very wonderful work had been done before the invention of printing from movable types. He would mention a circumstance in regard to the Mazarin Bible. It was that Fust was seized and charged with practising the black art, simply because people could not make out how he managed to produce so many Bibles at such a rate and at so low a figure—considering the high price of the manuscript Bibles. In the end he confessed how the work was done, and was liberated. On the subject of title pages which had been referred to, it was known that Whittingham followed very largely the style of the old Italian books. If anyone scrutinised the Pickering books they would observe that this was so. With regard to colour work, he could not help remarking that very great progress had been made in that direction. Some of the blocks made by Messrs. Carl Hentschel in three colours, for "Famous Pictures," and issued by Messrs. Pearson, were among the best pieces of work that had yet been seen. In conclusion, Mr. Jacobi heartily thanked the members for the reception which had been accorded to him.

Miscellaneous.

CEYLON TEA.

H.M. Consul at Chicago reports that in that district over one-third of the demand is for green tea, and a quantity of green Ceylon is now being put on the market. One firm at Chicago sells over 50 cases of green Ceylon tea a month. This tea has not yet the appearance of the Japan and China green teas, and looks as if it had been partially fermented, and the trade is in an experimental condition.

Of the 80,000,000 lbs. of tea consumed it is computed that 50,000,000 lbs. is natural or unfermented leaf, embracing the Japan and China green teas, 18,000,000 lbs. are semi-fermented leaf, Formosa and Foochow Oolong, leaving only about 12,000,000 lbs. of fully fermented leaf, China, Congo, and Indian and Ceylon teas.

Anyone contemplating entering the Chicago market with Indian and Ceylon teas must consider the situation carefully, as many men with years of experience in the trade there have found it impossible to make a living unless they sell all kinds of teas.

The British Vice-Consul at St. Louis reports that Indian and Ceylon tea is largely dealt in at St. Louis, and the demand would be increased if handled by an agency dealing in such teas alone and advertising them largely to the trade; it is bought mostly at seaports.

The British Vice-Consul at Kansas City reports that the trade in tea is being developed; no figures can be obtained as very little is cleared through the Kansas City Custom-house. There is a large quantity of green tea consumed, being chiefly of Chinese and Japanese origin. The taste, however, for Ceylon teas appears to be growing, and attention is again drawn thereto.—*Board of Trade Journal.*

General Notes.

Imperial Department of Agriculture for the West Indies.—This Department has commenced the publication of a Fortnightly Review, entitled, *Agricultural News*, with the view of supplying, in a popular form, information of an agricultural character suited to the requirements of the West Indies. A special feature of the *Agricultural News* will be information respecting the interesting work now going on at the chemical laboratories, botanic institutions, experiment stations, agricultural schools, experiment plots, agricultural shows, as well as a record of the very considerable activity manifested in promoting agricultural education in the colleges and schools in the West Indies. The first number is dated April 25.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 9...East India Association, Westminster Palace Hotel, S.W., 4 p.m. Mr. C. W. Whish, "Agricultural Banks in India."
Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m.
Tuesday, June 10...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Photographic, 66, Russell-square, W.C., 8 p.m. Professor J. C. Bose, "The Strain Theory of Vision and of Photographic Action."
Anthropological, 3, Hanover-square, W., 8½ p.m.
Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m.
Asiatic, 22, Albemarle-street, W. 4 p.m.
Wednesday, June 11...Geological, Burlington-house, W., 8 p.m.
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.
United Service Institution, Whitehall, S.W., 3 p.m. Commander A. S. Thomson, "Anchors: Old Forms and recent Developments.
Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.
Thursday, June 12...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.
Friday, June 13...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. G. Marconi, "The Progress of Electric Space Telegraphy."
Astronomical, Burlington-house, 8 p.m.
Physical, National Physical Laboratory, Bushey-house, Teddington, 3½ p.m.

Journal of the Society of Arts,

No. 2,586. Vol. L.

FRIDAY, JUNE 13, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's Conversazione will be held, by arrangement with the Council of the Royal Botanic Society, in the Gardens of that Society, Inner Circle, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 o'clock. The reception by Sir William Preece, K.C.B., F.R.S., Chairman, and the other members of the Council, will be held at the entrance to the Conservatory, near the Broad Walk, from 9 to 10 o'clock.

Two entrances to the Gardens will be used. The principal entrance faces the road leading to York-gate and St. Marylebone Church. It is less than half-a-mile from Baker-street Station, on the Metropolitan Railway. The second entrance is on the North side of the Gardens, near the road leading to Chester-terrace, and the east side of Regent's-park. A covered way leads from this into the Conservatory.

The central portion of the Gardens only will be used. The Gardens will be illuminated with coloured lamps, and also by the Kitson Incandescent Oil Light.

The Conservatory and Club House will be open.

The Royal Botanic Society's Exhibition of Rhododendrons will be on view, and there will be a special exhibition of roses and growing and cut flowers by Messrs. W. Paul and Son of Waltham Cross.

A selection of music will be performed by the String Band of the Royal Artillery in the Conservatory, and by the Band of the Scots Guards in the Gardens, commencing at 9 o'clock. The Red Hungarian Band will also play at intervals in the Gardens and in the Club-house.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards are now issued. In addition a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets, or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, 4th inst. Present: Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Lionel R. Ashburner, C.S.I., Sir George Birdwood, K.C.I.E., C.S.I., H. M. Birdwood, C.S.I., LL.D., Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., F. C. Danvers, Sir Juland Danvers, K.C.S.I., Sir John Jardine, K.C.I.E., Sir William Lee-Warner, K.C.S.I., General J. Michael, C.S.I., Edmund Neel, C.I.E., Alexander Rogers, and W. Martin Wood, with S. Digby, Secretary of the Section. The arrangements for next session were considered.

EXHIBITION OF ENGRAVING AND ETCHING.

The Board of Education have decided, at the suggestion of the Council of the Society of Arts, to hold during the early part of next year an Exhibition of Engraving and Etching, in the Victoria and Albert Museum, South Kensington. The Exhibition will consist of examples of copper and steel engraving, including line, mezzotint and stipple (plain and coloured), aquatint and etching. The Board are being assisted in the selection and arrangement by an influential advisory committee, which held its first meeting at South Kensington on the 4th inst. All communications respecting the Exhibition should be addressed to the Secretary, Exhibition of Engraving and Etching, Board of Education, South Kensington, S.W.

The proposal of the Council of the Society was that the Exhibition should include the various methods of illustration which have not been dealt with in the previous exhibitions held by the Department, viz., photogravure and the various photographic processes other than those applicable to typographic work. In the opinion of the advisory committee, this proposal was of too wide a scope for it to be adequately treated in a single exhibition, and they therefore recommended the Board of Education to confine the next exhibition to engraving and etching alone, and to defer to a later period the holding of an exhibition which might illustrate the various applications of photography other than typographical.

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, May 8, 1902; SIR EDWARD A. SASSOON, Bart., M.P., in the chair.

The CHAIRMAN, in calling upon Mr. Bennett to read his paper, referred to him as a leading journalist of India, and to his connection with the *Times of India*, a paper which had earned an enviable distinction as being one of the most far-sighted, as it certainly was one of the best-informed, journals upon matters connected with Asiatic politics.

The paper read was—

THE PAST AND PRESENT CONNECTION OF ENGLAND WITH THE PERSIAN GULF.

By THOMAS JEWELL BENNETT.

I need scarcely claim for the subject of the present paper that it has at all events the quality of actuality. An important debate in the House of Commons on an amendment to the Address in reply to the Speech from the Throne; a discussion now of many months' standing in newspapers and reviews; a number of papers read before various learned societies; and now and again telegrams from the near East recounting "excursions and alarums" in and about the *locus in quo*—all these have given to the Persian Gulf and the interests of Great Britain therein the status of a living question, of present day importance. In bringing it to the notice of the Indian Section of the Society of Arts I am constrained to observe certain limitations of space and subject. The temptation is strong to wander promiscuously over the very interesting field of the past relations of England and the East India Company with Persia at large—relations which began as far back as in the reign of Queen Elizabeth, if not earlier—and which in more modern times take their place in the history of the struggle between France and England for dominion in Asia. I must avoid this temptation, just as I must resist the inclination to deal fully and directly with such important subjects as the commercial rivalries of England and Russia in Persia; the means whereby England is to make sure of retaining in the southern provinces an influence commensurate with that which Russia has acquired in the northern; the bearing upon British interests and policy in the Gulf of the promised appearance in that region of Germany as a railway maker. One is, of course, prompted by recent discussions to enter upon inquiries connected with the designs of other Powers which, if effect should be given to them, would change the aspect of the Gulf question, and in the belief of many competent authorities would substantially act upon the balance of power in Asia, and modify, in a sense at once onerous and dangerous for England, her position as an Asiatic Power. But, although it will be impossible altogether to evade considerations of this order, only a secondary place must be given to them. I have to remember the constitution of this Society, which does not aim at giving facilities for excursions in political speculation, and which imposes upon those whom it invites to a place upon its rostrum something more than a bias towards the objective treatment of the subjects which they handle.

BRITISH ASCENDENCY A QUESTION OF FACT.

The condition, as it happens, is by no means an irksome one in this instance. A Minister of the Crown, in answering a question concerning the attitude of the British Government in the affairs of the Gulf, said, at the opening of the present session of Parliament, that "the ascendency of Great Britain in the Persian Gulf"—which he declared to be the foundation of British policy—was "not merely a question of theory, it was a statement of fact;" and as such it will be dealt with to-day. A prominent Frenchman, in objecting to the position of England in that part of the world, declared, some years ago, that she had, without a shadow of right, constituted herself the general arbiter and guardian of the Gulf. It is precisely this description of our status—which appears to represent a view widely prevalent abroad—that challenges disproof. The disproof that history affords is direct, emphatic, and convincing. If England has become, in any sense, the arbiter and the guardian of the Gulf, as M. Deloncle, the leader of the French Colonial party, says she has, it has not been through a restless ambition urging her on to the control of the waste places of the earth, but in obedience to the calls that have been made upon her in the past to enforce peace between warring tribes, to give a free course to trade, to hold back the arm of the marauder and the oppressor, and to stand between the slave-dealer and his victim.

The Nature of British Claims in the Gulf.

We have had to listen occasionally—always I trust with respect—to the claims of neighbour nations to a position of preference in certain regions, which are based upon historic association. The claims of France in the Levant, for example, while they are of a somewhat platonic kind, have at least this justification, that they are traditional, and, if mainly sentimental, have a certain prescription in their favour. Only the other day a distinguished member of the Senate claimed for France "a moral patrimony of glory and grandeur" in that region. But in the case of England and the Persian Gulf the position is unique. Although England—beyond two brief occupations of the island of Karak, and the continuous possession of Bassadore, on the island of Kishm, as a station for cruisers—has at no time enjoyed, or even asked for territorial acquisitions in that region, she has for generations borne burdens there which no other nation has ever undertaken anywhere, except in the capacity of sovereign. She has had duty thrust upon her, without dominion. She has kept the peace amongst people who are not her subjects; has patrolled, at intervals, waters over which she has enjoyed no formal lordship; has kept, in strange ports, an open door through which the traders of every nation might have as free access to distant markets as her own. These efforts, and the sacrifices by which they were accompanied, are forgotten by our neighbours when they ask us by what right England flies her flag somewhat higher than others in the Gulf; they are forgotten, too, by Englishmen who have been urging lately that we should buy an understanding with another Power by inviting that Power to plant itself upon the waters whose peace we have kept.

Lord Curzon and Persia.

Before setting forth the various stages in the evolution of the British status in the Gulf, one observation has to be made as to the sources of the information which bears upon the subject. They are abundant, and they are not difficult of access. But whoever examines them, no matter with what searching industry, and then turns, as he is bound to do, to Lord Curzon's monumental work on Persia, will find that well nigh every footstep in his wanderings through the literature of the subject has been already trodden by that most untiring and most vigilant of explorers. His Excellency is entitled to the thanks of his countrymen, not only for the clear enunciation, in sentences which have already taken their place amongst the axioms of the discussion, of a policy worthy of an imperial people, but for the abundance and exhaustiveness of a work which so competent an authority as Dr. Sven Hedin, himself also an authority at first hand upon Persia, declared in Bombay the other day to be a monument of industry and knowledge.

The Caspian Trade Route.

The earliest connection of England with Persia had little or nothing to do with the Gulf. It was by the Caspian, and not by the Gulf, that the pioneers of British trade with Persia made their way into that country. In each case it was to a great trading company that the enterprise was due. What the agents of the East India Company were destined to do on one line of approach in the 17th century, the agents of the British Muscovy Company did in the 16th. The discovery by Burrough and Chancellor, two of Cabot's "Merchant Adventurers," of the port of Archangel, may be said to mark the first stage in a movement which opened up the Caspian and the lands beyond to English trade. It was followed five years later—in 1557—by the incorporation, under a charter of Philip and Mary, of the British Muscovy Company, under whose auspices Anthony Jenkinson set out on a commercial voyage of discovery, in the course of which the banner of England was hoisted on the Caspian—that sea in which, since the Treaty of Gulistan, even the Persian flag has not been tolerated on armed vessels by Russia. Jenkinson, who penetrated as far as Bokhara, brought back an account of the trading potentialities of Persia which, though it went to show that the Persian trade lay mostly on the western side, was deemed to be encouraging. On his second voyage to Persia Jenkinson took with him a letter from Queen Elizabeth to Shah Tahmasp. The enterprise then moved apace. The Muscovy Company, in 1563, sent three agents to the Persian Court—then at Kasvin, a town on the route of the present Russian-made road from Resht towards Teheran—and they seem to have obtained sufficient assurance of protection to warrant them in steadily pursuing their trading ventures in North-Western Persia. The Company was filled to the full with the courageous spirit of Elizabethan adventure. Before it had been in existence a quarter of a century it had obtained a footing, not only in Tabriz, but in the Caspian province of Mazanderan, and in Khorassan—territories now virtually monopolized by Russian trade—its movement thus far eastward being at the time looked upon as a stage in its progress towards far Cathay. Yet, despite the enterprise of the Company, and the daring and endurance of the men who served it on these perilous adventures, the history of this period is the history of a failure, and no serious attempt to re-establish the Caspian trade route to Persia was made until the reign of Peter the Great. The story of this revival is told by Jonas Hanway, in a work which, for straightforward, ingenuous, and informing narrative qualities, has a front place amongst the books of travel belonging to the 18th century. Hanway, who was as much given as the old factors of the East India Company in their official correspondence were to write of business matters in a religious spirit, calls to mind, in the introduction to his work, the religious zeal of the Russia Company in building a church at St. Petersburg, and asks, "may it not be expected that the Supreme Being, who directs all events by His providence, will enable you either to revive your Caspian trade, or to strike out some other branch more beneficial?" Events, indeed, had for a time favoured a revival of the ventures abandoned in 1581. Peter the Great, whose commercial policy had been marvellously liberal for his time and country, had shortly before his death opened negotiations with London merchants for reviving the Muscovy Company's endeavour to establish a trade with Persia through Russia. Czar Peter, Hanway says, thought none had so good a right to a commerce through his country to Persia as the English—against which we may set the modern policy of Russia in charging her full protective tariff on all foreign goods in transit. The Czar's liberal aspirations, however, were not realized until ten years after his death, when the Empress Anne sanctioned a treaty providing for the transit of British goods for Persia, and *vice versâ*, on payment of three per cent. duty. This was met on the side of the British Government by an Act enabling the Russia Company to import Persian silks through Russia, a measure necessitated by certain obstacles presented by the Navigation Acts. Yet the undertaking, despite the active goodwill of the Russian Court, was not more successful than that which had failed a century and a-half before. Russian favour had gone so far as to allow the Company to build ships on the Volga, for the purpose of the Trans-Caspian trade, and at one time the venture seemed so promising that the East India Company saw in the Russia Company a dangerous rival to its own trade with Persia and the East. But although it is difficult to imagine any conditions under which permanent success could have been assured to an enterprise which might, at any moment, have been brought to an end by the caprice of an autocrat at St. Petersburg, it was nevertheless to a much less conspicuous personage, and he an Englishman, that the failure of the enterprise was immediately due. John Elton, whom Lord Curzon describes as "the real father of the revived scheme," had all the courage and daring, the love of adventure, and the resourcefulness that go to make up the character of the true Viking of commerce. He had been in Central Asia, and had obtained from Nadir Shah's regent permission to trade between the Caspian and the Indies. Armed with this, he had petitioned the British Minister at St. Petersburg, urging that Meshed, then the seat of the Shah's Government, should be made a centre for British trade with Bokhara, Afghanistan, and India, for it was easier to send goods thither from St. Petersburg than it was to send them from London to the latter place. British merchants, he urged —with a fine hopefulness that we sigh to think of in contemplating the present distribution of trade in Central Asia—had no formidable rivals to contend with there. All they needed was to have a fleet of their own on the Volga and the Caspian, to be manned by English and Russians in equal numbers, and a head-quarters at Meshed, with a branch at Resht, whose chief factor should be British Consul. Elton's belief in Northern Persia as a field for British trade was indicated in his observation that Meshed was beyond the reach of the East India Company, who had already closed their factory at Ispahan, while Dutch trade in that place was declining. Elton did more than any one else to shatter his own dream. Scarcely had the British ships been launched on the Volga than he suddenly entered the service of Nadir Shah, for whom he undertook to build a fleet. To cut short a long story, the relations between the Company and the Russian Government were seriously disturbed by the proceedings of this wayward Englishman, and a decree from the Empress in 1746 put an end to the British trade with Persia *viâ* the Caspian.

The history of the British Transcaspian trade route to Persia has small direct bearing upon our subject; it is, however, at least interesting as a study in contrasts. Let us now trace the origin of that British connection with the Persian Gulf which has been brought under such prominent notice in recent years.

The Portuguese and the Gulf.

In the Persian Gulf, as in India, the Portuguese were the first comers. The acquisition by that nation of a firm footing in the Gulf in the opening years of the 16th century was one of the first fruits of Vasco Da Gama's discovery of the Cape route to India. Albuquerque, whose instructions were to blockade the Red Sea and establish a depôt on the island of Socotra, interpreted his orders as freely as many another great captain in the East has done, and sailed instead for the Gulf, where he laid the foundation of a power that lasted for nearly a century and a half. He began by attacking Ormuz, which was already a great trading centre, and completed his task by devastating a number of towns on the Oman coast, which were subsequently occupied and fortified. The Portuguese supremacy in the Gulf was asserted in the most uncompromising way by forbidding any native vessel to trade there without a pass. In the middle of the 16th century the Turks endeavoured in vain to challenge it. Thirty years later the attack was repeated, so far with success that the Portuguese were defeated and plundered at Muscat, which had long been a trading station dependent upon Ormuz. Subsequently they erected fortresses at Muscat and at other points on the coast. The event which did most to bring about the decay of their power in the Gulf was their expulsion from Gombroon, the modern Bunder Abbas, which had become an important trading station on the mainland opposite Ormuz; this was followed by their expulsion, under circumstances which I shall shortly relate, in 1622 from Ormuz itself.

The Beginning of the British Connection.

The political connection of England with the Gulf really begins with this important event. The East India Company's representatives at Surat had four years before despatched a trading vessel to Jask. Perhaps King James had future as well as past favours in his mind when he wrote in 1620 to Shah Abbas thanking him for his treatment of English traders in his country, and asking for the additional privilege of a factory near Jask where they might enjoy the liberty of trade already conceded to them. For Shah Abbas was fully conscious of the value of the friendship of the English. They were a growing power, even in the Gulf, as they proved when two of their vessels, blockaded at the entrance of Jask Harbour, returned to Surat for reinforcements, forced their way in, and afterwards gave the Portuguese such a beating as earned fame for them in all those waters. If proof were wanted that it was under pressure of circumstances, rather than of deliberate purpose, that the English in the East mixed in the political affairs of other people, we have it in an incident that occurred about this time. A party of British traders on their way down from Ispahan to Jask with a large consignment of silk are stopped by the governor of Shiraz, not for purposes of plunder or oppression, but solely to force the English to join the Persians in resisting Portuguese aggression. Under an agreement which was then come to, the Council at Surat despatched a fleet consisting of five ships and four pinnaces, which co-operated with a Persian force in reducing Ormuz, and compelling the Portuguese to take refuge in Muscat. In return for this service various substantial advantages were conceded to them. The spoil was to be equally divided between the allies; the castle of Ormuz—though this part of the agreement was not carried out—was to fall to the English, who, on condition that they maintained two ships of war in the Gulf to safeguard navigation, were to receive half the customs of Gombroon (Bunder Abbas), and their goods were to be admitted, duty free, into that port.

This, as has been said, was the beginning of the political connection of the English with the Persian Gulf—the first occasion on which the East India Company intervened in its affairs as a fighting, as well as a trading body. But we must turn back a few years to trace more fully than we have yet done the first attempts of the Company to obtain a recognised footing in Persia.

EARLY ADVENTURERS.

The Company had not been incorporated ten years before its agents began to make their way overland into Persia. Two of them, having journeyed to Ispahan, reported that this place might be made the centre of a profitable trade "if our ships, with safety, might trade in the Persian Gulf." Two others, John Crowther and Richard Steele, followed them four or five years later, and they managed, with the help of Sir Robert Sherley, to obtain a firman from Shah Abbas, ordering the governors of all seaports in Persia to kindly entertain the English shipping. Two years later saw not only the establishment of a British factory in Ispahan, but an important endeavour to place the trade of the Company, with Persia, on a recognised footing. The factors at Surat, notwithstanding the strong recommendation to the contrary of Sir Thomas Roe, King James's ambassador at the Court of the Great Mogul, determined to dispatch a cargo of goods for Jask. Edward Connock, an adventurous person who had had long experience in trading in Turkey, was chosen to direct the venture. There was much more in it than an endeavour to dispose of a surplus stock of merchandise which the factors had left on their hands. It involved a mission to the Shah for the purpose of procuring trading privileges, a mission which was made difficult not only by obstacles put in its way by the Portuguese, but by hatreds and rivalries in Connock's own following. The story of this adventure is told in letters from Connock both to the Company at home and to the factors in Surat, which are to be found in Mr. Foster's admirably edited selection from the "Letters received by the East India Company from its Servants in the East," the publication of which, under the patronage of the Secretary of State, has made accessible a mass of correspondence of distinct historical value. Of Connock himself, nothing better can be said than has been said by Mr. Foster in his introduction to the fifth volume of the series, that which relates to the year 1617:—"Ambitious, fussy, strangely wanting at times in tact and judgment, he made many enemies, and left few friends; yet the honesty and unsparing energy with which he carried out the duty entrusted to him command our respect, and, on the whole, his is a welcome addition to our gallery of portraits of the men who founded English trade in the East." We see in these letters a rooted distrust of our secular rivals the Portuguese. Writing from the Shah's camp, which was then twenty-four days' journey from Ispahan, Connock explained that his previous correspondence, sent through the English Consul at Aleppo, had had to be written in cipher, "fearing the Portuguese." Portuguese hostility to the English had declared itself in the person of an Augustine friar, agent at the Persian court for the King of Spain—under whose rule Portugal had been since 1580. Connock complains bitterly of the advantage which his quicker footed rival had gained over him. "With what speed I might," he says, "I hasted after him; but the friar, being well horsed, arrived at this court two days before me, when with his proffers of large sums, and with larger lies, he attempted our dismission. He had possessed this king (by a second) how that myself was not sent by his Majesty our king, but by merchants"—an attempt to turn to account the difference between the King's commission and the Company's of which the later records of our relations with Persia furnish some lamentable examples. Connock had to thank the Spanish agent for having to wait ten days before he could have audience of the Shah. But he "countermined" his enemies' works—"not without some expense," he naïvely admits—and then when he once comes face to face with the Shah all seems to go well. He asks for "amity, trade, and commerce between the two kings and their subjects," and makes short work of the objection of the Spanish agent, who was present during the interview, that if English ships were allowed at Jask they might intercept the Portuguese traffic with Ormuz. The English, it was complained, took Portuguese ships wherever they could. "I assured the King," Connock writes to the Company, "that till the Portingalls began with us we gave them no offence." Connock knew how to shape an argument as well as to counterwork a rival.

He told Shah Abbas that he was King of Jask just as the Mogul was King of Surat, and all he was asked to do was to confederate with the King of England, giving his subjects the same liberty of trade in Jask as the "King of India" had given them in Surat. But there was something more than Connock's arguments to prevail with the Shah. The English had commended themselves to him by a directness and honesty which we are proud to think have in the main characterised their conduct in Asia from that day to this. "The King," Connock says, "openly told his lords the English were a people free from lying and deceit, but that the Portingalls had any time these twenty years told him not one true word." Connock got what he asked for. The Shah undertook that regular shipments of silk should be made from Jask, and that tin, cloth, sugar, spices, and other commodities should be taken in exchange. Jask was to be fortified, though the fortifications were to remain under Persian control. Connock had an unbounded faith in the future development of the enterprise which he had thus brought to a happy fruition. He anticipated that the trade in silk, which passed through Turkey, and was thence distributed through Europe, would be diverted through Jask, and that, in a few years, all the silk made in Persia would pass through English hands.

SIR THOMAS ROE AND CONNOCK.

Sir Thomas Roe, still busy with his embassy to Jehangir's Court, and apparently influenced by a professional distrust in a mere merchant's ability to carry out a diplomatic mission, did not look quite kindly on Connock's mission, and took a more modest view of the possibility of trade with Persia; yet, even Roe had recognised the danger of allowing Spain, to whom Shah Abbas had some time before made overtures through Sir Robert Sherley, to acquire a monopoly of the Persian silk trade, and, acting upon his instructions to "settle the trade with Persia," he endeavoured to bring about a new treaty with the Shah, in which provision should be made for favourable tolls and customs, for the assignment of "a safe port wherein our ships may ride, without peril of the seas and danger of the enemies," and for the acceptance, at stipulated prices, of at least half the value of the silk exported in English commodities. These terms appear to have been too cautiously drafted to commend themselves to the Shah, who refused at first to go beyond confirming the arrangement made with Connock. The death of the latter, at a day's journey from Jask, while on his way to recover a consignment of silk detained by the provincial governor, was preceded by a strange repentance. On his death-bed, we are told, he "grieved that he had written to your honours so much to the disgrace of a Portuguese friar at Ispahan," a circumstance which led the not very friendly narrator to remark that he had lived an atheist and died a Papist.

THE ENGLISH AT BUNDER ABBAS.

The expulsion of the Portuguese from Ormuz was followed by the establishment of the English at Gombroon, on the mainland—the town which, under its modern name of Bunder Abbas, has been in recent times freely spoken of as a possible or even probable outlet of the railway by which Russia is credited with a desire to obtain access to the Gulf. We must not over-estimate the value of the rights which the Company acquired in recompense for its assistance in restoring Ormuz to the dominion of the Shah. They were, as has been stated, to take half the customs of the port; but their share soon dwindled to an insignificant sum, and their position was so far from being an exclusive one, that a French and a Dutch factory were established there before the end of the reign of Shah Abbas, who died in 1628. But it is clear, nevertheless, that as time went on, the English did acquire an exceptional status in the Gulf, and that at a very early period in the history of the English connection with these waters there may be found the germ of the larger responsibility and influence which this country was afterwards to assume there. The Persians, who, Sir John Malcolm tells us, at all periods of their history abhorred and dreaded the sea, were glad to secure an undertaking from the Company at the time of the expulsion of the Portuguese from Ormuz, to maintain two ships in the Gulf to protect trade, and six years later the Surat Council went in excess of this stipulation in sending five vessels to revive and increase the trade with Persia, and carry on naval operations against the Portuguese. (Low's "History of the Indian Navy.")

In 1669 the Council at Bombay were urging the Court at home to fit out three armed vessels to serve as convoys for the Company's trade in the Gulf, while ten years later the despatch of a squadron under the King's Commission to demand payment of customs arrears showed that the Company were not disposed to relinquish their rights in the Gulf.

During the reign of the four weak Princes who succeeded Shah Abbas, though the Persian dominions were reduced by Turkish conquest, and the Arab rulers of Muscat took possession of various islands in the Gulf, the position of the English was strengthened in some important particulars. Shah Abbas's firman was renewed by his immediate successor, and a Persian force was sent to Bunder Abbas to protect the English factory against the Portuguese, who were threatening a renewal of hostilities, while the English offered to send ships to cooperate with the Governor of Fars in dislodging the Portuguese from Muscat, knowing that if they had not done this the Dutch would have seized the opportunity of ingratiating themselves with the Persian Court. The Dutch, indeed, were threatening a rivalry as embarrassing as that of the Portuguese had been. They sent eight ships to Bussorah, where the English had opened trade in 1635, and almost ruined the factory there. At Bunder Abbas they proved such bad neighbours that the Company were forced to remove the bulk of their property to Bussorah, and though the factory was retained until 1761, for the last century of its existence it was the seat of a very insignificant business. It enjoyed, in those days, the reputation of being one of the most insufferably hot places in Asia, and that reputation it has maintained to our own day. The closing of the establishment at Bunder Abbas was almost immediately followed by the opening of a factory at Bushire, which has since become the political and commercial headquarters of the British in the Gulf.

The Growth of British Privileges.

The event was important for other reasons. The firman under which the Bushire factory was established frankly concedes to the English a peculiar and privileged position, the result, we may fairly conclude, of the growth of their influence as a trading power in India, and of the success with which they had overcome the hostility of their old rivals and enemies. Karim Khan's firman, of 1763, was granted to W. A. Price, as "Governor-General for the English nation in the Gulf of Persia," and Benjamin Jervis, Resident, in response to a demand for "a grant of their ancient privileges in these kingdoms." It was expressly made out of the Shah's great friendship for the English nation, and it concedes not only an unbounded, but a virtually exclusive liberty of trade to the English. No customs were to be collected on goods imported or exported by them. A monopoly in the trade in woollen goods was conferred upon them, and it stipulated that "if any person whatever attempted to bring such goods in clandestinely it should be lawful for the English to seize them," and that no "European nation whatever is to be permitted to settle at Bushire so long as the English continue a factory here." We may doubt if this plain defiance, in our interest, of the principle of the open door, was fully carried into practice. But the firman unmistakeably indicates the privileged nature of the position which it was intended to confer upon English trade and traders. A site for a factory—which was to be built at the expense of the Sheikh of Bushire—as well as a garden and burial ground, was granted; the servants of the English were to be exempt from the local jurisdiction, and the English were to hoist their own colours, as they had been allowed to do at Bunder Abbas, and to have twenty-one guns for saluting. We must not forget that this concession was granted during the reign of a weak ruler, and in a time of more than usual misgovernment and unsettlement. But taken in connection with a new firman, granted in 1788 by Karim Khan's nephew, who expressed his desire that the English merchants should "sleep in the cradle of security and confidence," it shows that towards the end of the 18th century England had attained a position in the Gulf to which none of her competitors could lay claim. If any single incident could emphasize this we find such an incident in the presence at the siege of Bussorah by the Persians in 1775 of a squadron of the Bombay Marine, comprising five vessels carrying nearly a hundred guns. A power so represented was a power to be reckoned with.

The White Man's Burden in the Gulf.

We now come to a chapter in the history of the English connection with the Gulf in which little is heard of our rights and privileges in those waters, but much is heard of our responsibilities. Here, if anywhere, in her world policy, the "white man's burden" has rested upon England; and despite occasional reluctance to carry its full weight, she has borne it, on the whole, unselfishly and well. We have seen how, at the time of their cooperation with the Persians in the expulsion of the Portuguese from Ormuz, the East India Company undertook to keep two vessels in the Gulf for the protection of trade. Now the

English were here beginning to do for Persia what the Persians have never been willing to do for themselves. The peculiar attitude of Persia towards sea polity is illustrated in the dimensions of the Shah's navy, which consists today of a solitary steamer, whose toy-shop qualities are indifferently concealed by an armament scarcely more serious than the *Persepolis* herself. In looking, as some of us have done occasionally in the Harbour of Bombay at this diminutive embodiment of the sea power of Persia, it becomes easy to realise Sir John Malcolm's remark, already quoted, that "the Persians at all periods of their history have abhorred and dreaded the sea." The historical consequence of this national characteristic has been, as Malcolm pointed out, that the Arabs have possessed themselves of the islands of the Gulf, and of almost all the harbours along the coast, their position there being conditioned at times by a real, and at others by a nominal obedience to the Shah's Government. The Arab dominion of the Gulf was for long periods the dominion of piracy, and very early in the evolution of the English power in Asia the obligation to control and suppress that evil forced itself upon the courageous men who first at Surat, and then in Bombay, were engaged in laying the foundations of our Oriental Empire. Lord Curzon justly praises their work when he pays tribute to "the indomitable gallantry with which, in ages when merchants required to wield the sword almost as deftly as the pen, the representatives of English trading companies carried the flag and the merchandize, and the high name of Great Britain, into lands where all risked, and many lost, their lives in each venture." Those who are anxious to follow the story in detail will find it set out for them in Lieutenant Low's "History of the Indian Navy," which does no more than justice to these hardy police of the Eastern waters when it records that "the Gulf afforded to the service a fresh field for the display of those qualities of enterprise and skill which they had already exhibited on the west coast of India." By this intervention three results of capital importance to humanity were achieved —the suppression of piracy, the cessation of war between the chiefs, and the approximate extinction of the slave trade. Considering the extent of the resources at the command of the Company when they began their task, and the strength of the marauding elements, the work was one of really formidable proportions. Towards the end of the 17th century, one of the Company's officers in the Gulf reported that the Arab fleet consisted of five large ships, carrying five hundred men, and twelve cruisers. The Arabs had already pillaged Diu, ousted the Portuguese from Mombasa, and seized the other Portuguese possessions on the African coast, and the Persian authorities were so alarmed at their prowess that they asked the Company for help against them. One of the chiefs of the Joasmis, a tribe who subsequently gave us much trouble, included in his navy a ship carrying eighty guns.

The War with Piracy.

It is, however, to the earlier part of the 19th century that the history of our armed intervention in the Gulf mainly belongs, for it was not until the tribes were welded together, and incited to pillage and outrage by the Wahabi propagandists, who had extended their influence from Central Arabia to the coast, that the lawlessness in the Gulf reached its height. The Bombay authorities were not hasty in the retributive, or even the protective, measures which they adopted. For many years, the policy they pursued was one of non-intervention, varied only when some particularly flagrant depredation stirred them to action. In one noteworthy instance, they appear to have been open to the charge of culpable indulgence. In the year 1794, the Joasmis, having previously captured a British despatch-boat, attacked, in Bushire Roads, the Company's brig *Viper*, carrying 14 guns, and though the attack was beaten off, the English had 32 men killed out of a crew of 65, amongst the casualties being the death of the Lieutenant who was commanding, and who had refused to leave the deck when severely wounded. The outrage was aggravated by treachery, for in a moment of impolitic confidence the *Viper* had parted with some of her own ammunition to the Joasmi dhows, so that they might protect themselves against the Arabs of Sohar. The Bombay Government took no notice of the insult, and thereby gave colour to the accusation that they were pursuing a dangerously lenient policy in the Gulf. It was not long before this mistaken policy yielded its natural fruits. While it was still a standing instruction to the officers of the Bombay Marine that they were on no account, under pain of the severe displeasure of Government, to molest the Joasmi pirates, two English merchantmen on a voyage from Bombay to Bussorah were attacked by the Joasmis. In the same year, 1805, a 22-gun cruiser belonging to the Company was attacked by the same marauding tribe, who attempted to capture her. The disastrous failure of the attack in no degree abated the audacity of the Joasmis. They sued for peace next year, under pressure of a combined attack by the British and their ally the Imam of Muscat, and a brief truce ensued. Hostilities were resumed the next year under circumstances which made it plain then—as it should be plain to-day—how intimately the politics of the Gulf are connected with the politics and even the security of the British power in India. The proceedings of the Gulf tribes ceased to be a matter of local concern when the audacious pirates, who had shortly before undertaken never again to molest British shipping, appeared off the Guzerat coast, captured twenty native craft, and then proceeded to harass the coasts of Cutch and Sind. No fewer than three expeditions, in the third of which—that of 1819—a fleet of twelve vessels, carrying over 200 guns and three thousand troops, was engaged, were necessary for the subjugation of these almost incorrigible sea rovers. Their operations covered the whole of the Gulf and the Arabian Sea up to the coasts of Bombay and Sind. We find them at one time impudently demanding tribute from the Bombay Government as the price of an unmolested passage for the Company's merchantmen. Failing to exact this they laid hands on everything that came in their way. Four vessels on the voyage from Surat to Mocha were seized, involving a loss of ten lakhs of rupees, and their crews murdered, notwithstanding that they sailed under a convoy of His Majesty's and the Company's ships. They ravaged the coast of Kathiawar, laid hands on the Gaekwar's port of Dwarka, and sailed defiantly in Indian waters a fleet of sixty-four vessels manned by seven thousand desperadoes. While such were the conditions in the Arabian Sea, the reign of terror in the Gulf was so pervading that the masters of merchant vessels feared to leave any port without an escort. It does not concern us now to ask whether the authorities in Bombay were as prompt as they might have been to rise to the full height of their responsibility, and no good purpose could be served by attempting to pronounce upon the controversies of those days in which that question was hotly discussed. But the mere fact that such a controversy arose would be a sufficient answer to-day to any suggestion that England had incontinently rushed into the politics of the Persian Gulf. This, too, should be noted, that when in 1820 England made a general treaty with the chiefs of the maritime tribes for the suppression of piracy it was not her own protection alone that she sought for. In forcing the tribes to abandon piracy "against any nation whatever," she was solicitous for the common good, and was serving other nations as well as herself. And if this were a detailed history of the dealings of England, through her servants in India, with the Persian Gulf, much more would need to be said of the efforts and sacrifices which this nation has made to bring about that *Pax Britannica* in those waters which other nations—and too many Englishmen—regard as a spontaneous and easy evolution of the centuries. There is time here to tell of one stirring episode, which has been chosen because it is characteristic not only of the peril which Englishmen have faced in the Gulf, but of the spirit in which they have confronted it. I take it from Lieutenant Low's account of the punishment which was inflicted by the East India Company's sloop *Elphinstone*, Captain Sawyer, upon a squadron of seven war vessels with which the chief of the Beni Yas ventured to challenge the supremacy of the British flag in the Gulf:—

> "As the evening drew near (Lieutenant Low says) Captain Sawyer saw he had a desperate game to play, for if once they could only grasp his vessel they would pour hundreds of men upon his decks, and eighty British seamen, with about thirty or forty natives and marines, could not hope long to maintain so unequal a conflict. 'Now,' said he to his men, 'the first shot here is half the battle; put a third round into the quarter deck gun, and don't fire till I give the word of command.' He then steered, with a light breeze, for the enemy, and perceiving two of the largest vessels sufficiently apart to pass through, he said to the master, 'steer straight between them.' When within a few yards the Arabs leaped upon the bulwarks, two men with grappling irons, and the remainder with sword and spear. A young officer covered one of the men with the grappling irons, and another marksman took the second, and both fell dead with bullets through their hearts. In return came a shower of spears, and then one heard the clear calm voice of the captain 'steady, ready, fire.' From eighteen 32-pounders there poured a storm of shot, scattering death and destruction around, and making the little ship quiver from stem to stern. The two vessels were riddled like sieves, and those of the Arabs not killed or wounded sought death by leaping overboard. For a passing second there was a dead silence, the concussion of the salvo having produced a calm. Then was heard a storm of shouts and groans from the Arabs, mingling with the

exulting cheers of the British seamen, and above the din rose the word of command from the captain, 'first division of boarders away!' In a moment the men left their quarters, prepared to cope with some hundreds of desperadoes whom they had seen swarming on the decks and bulwarks of the five remaining vessels. But the scene was now changed. The Arab crew, appalled by the dreadful lesson thus read to them, rapidly got out their sweeps, and pulled for their lives. Boats were lowered, and the sheik's baggalah, the largest of the squadron, was boarded, when it was found that one of the round shot had broken to pieces the caldron of boiling oil, specially prepared for the heads of the Christians, and scattered the contents around. In the cabin were discovered, paralysed with fear, and prostrate on the deck, a young Hindu lady and her father, whom the pirates had taken from a vessel the day before."

Relations with the Tribes.

It would be going beyond the scope of this paper to follow in detail the dealings of the East India Company and its successors with the tribes of the Persian Gulf and the Oman coast. The intimacy of these relations is, however, a matter of practical present day interest, and should always be borne in mind in the presence of suggestions that England should step aside for the convenience of any new comer who may desire to further his own policy by taking up a predominating position on the Gulf. Let us take Bahrein, for example, the seat of the pearl fishing. The chiefs of that island have been under British influence for nearly a century. They joined in the general treaty which was signed in 1820, after the third of the important expeditions in which the East India Company discharged its obligations in respect of the policing of the Gulf. Egypt in 1837, Persia in 1843, and the Turkish Government on various occasions subsequently, have in vain endeavoured to undermine the position of the Bahrein chiefs. The Porte has invariably been told, as our answer to such overtures, that the British Government has treaty relations with Bahrein as a protected State, and that we cannot acknowledge any arrangement which would bring it under Turkish sovereignty or protection. Some of our neighbours are inclined to impute selfishness to England when they find her thus marking off the outlying regions of the earth for her special care. The answer to any such suggestion as this will be found, not in any mere verbal justification of her policy, but in that policy itself. Let us take, for example, this leaf from the records of British connection with this same chiefdom of Bahrein. In 1861 the Bahrein chief threatened the tranquillity of the Pirate Coast by blockading certain Wahabi ports. The Indian Government, as policemen of the Gulf, promptly came down upon him and made him enter into a treaty, having for its object "the advancement of trade, and the security of all classes of people navigating or residing upon the coast," and specifically binding him to abstain from war, piracy, and slave importation. And when this instrument failed, seven years later, to prevent Mahomed bin Khalifa from again launching upon his career of piracy, the policeman's bâton had to be brought into requisition. A British naval force, with the Resident of Bushire as political officer, goes to Bahrein, seizes the truculent chief's war vessels, and deposes him in favour of his brother. This must stand as a typical instance of the service that England rendered to humanity by her measures for preserving the peace of the Gulf during the last century, a service which found formal embodiment in the Maritime Truce at first imposed upon the warring chiefs on the coast in 1836, renewed from time to time, and made perpetual in 1853. The old law of retaliation for aggression, which belongs to the code of the natural man, was hereby superseded, and these wild Arabs of the Gulf pledged themselves to refrain from righting their own wrongs, appealing instead to the Resident at Bushire, or to the Commodore of the Indian Navy at Bassadore, for it was solemnly recited in this beneficent instrument that "the peace now concluded shall be watched over by the British Government." Once only did England divide her responsibility in regard to any of the lands adjacent to the Gulf, and that was when, in 1862, she associated herself with France in guaranteeing the independence of the Sultan of Muscat — a compact whose influence we were, to say the least, fully conscious of during a certain exciting episode on the Oman coast three years ago. The Anglo-French declaration of 1862, however, has in no serious degree modified our relations towards the rulers of Muscat, who for more than a century have been in intimate dependence on the British Government, looking to that Government for help in time of internal commotion or of pressure from their enemies, and accepting the counsels of British officers as those of friends and protectors. But for the prompt assistance of the Bombay Government, who sent ships of war to Muscat, and intervened between the chief and his turbulent followers, the long reign of Seyid Said would have come to an untimely end in 1829, when he had gone to Zanzibar to suppress a rising. Similar episodes, similarly ended, occurred in 1832 and 1852, and it was entirely due to the political and military support of the Bombay Government that this Imam was able to retain possession of his territory during a reign of thirty-five years. It was by British influence, too, that a war of succession to the Zanzibar and Muscat territories was prevented at his death, and that the division was effected which gave Zanzibar an independent position.

THE SLAVE TRADE.

In her efforts to put down the slave trade in Persian waters England has had no help from any of the Powers who seem to envy the position she has gained there. These efforts first took definite shape in a treaty concluded with Seyid Said, the ruler of Muscat, in 1822, for the suppression of the traffic in slaves by means of search of suspected vessels, the line of search being extended so as to include Kutch and Kathiawar, with which the trade had been carried on much too freely to satisfy the conscience of the Company. The treaty of 1836, establishing the Maritime Truce, was a step in the same direction, but it was interpreted as forbidding, not the slave trade generally, but kidnapping only, and an extensive trade was still carried on from the Red Sea and the Persian Gulf with native States in Western India. How extensive it was may be gathered from the fact that in the early thirties—of course before the British conquest of Sind—the annual imports of slaves into Karachi alone amounted to between 700 and 800. In this matter, as in others, we hastened slowly. It was by a series of engagements, ending with one concluded by Sir Bartle Frere, in 1873, that we secured the full co-operation of the Imams of Muscat in our effort to clear the Gulf of slaves, and by a similarly gradual process we enlisted the Trucial Chiefs in the work, and at length acquired the full right to detain, search, and confiscate within an adequate area vessels engaged in the forbidden traffic. The efforts to secure the co-operation of the Shah's Government in the enterprise began at Teheran in 1848, when the British representative had to be content with a compromise, for the Shah, unable to resist the opposition of the priests to the total abolition of the traffic, would only consent to a prohibition of slave importation by sea. Even this concession, he explained, oddly enough, he only made "on account of the goodness of Farrant Sahib," Lieut.-Colonel Farrant being the British agent with whom the negotiations were conducted. Shortly after this, the Persian Government agreed that both the Queen's and the Company's warships should, for eleven years, be permitted to search Persian vessels for slaves—an agreement which was renewed and extended by the Treaty of Paris in 1857, and re-affirmed in 1882 in a treaty empowering British cruisers to visit and detain merchant vessels under the Persian flag engaged in, or reasonably suspected of being engaged in, the slave trade. If our efforts to keep the Gulf free from the curse of slavery have fallen short of the success that we have hoped for, it has not been through lack of vigilance, either in the old days when, with Bassadore as their headquarters, the Indian Navy squadron kept watch and ward against slavers, or, in more recent times, when British men-of-war have had to see slavers plying with impunity under the protection of a flag on which red, white, and blue—on the Gulf, at all events—read for something different from Liberty, Equality, and Fraternity. This is not an occasion for speaking all that may be on one's mind on a subject which cannot be discussed freely without jarring upon the susceptibilities of a friendly nation. But this at least may be said. Ten years ago, M. Deloncle, the leader of the Colonial party in the French Chamber, who, as we have seen, complained that England had, without a shadow of right, constituted herself the general arbiter and guardian of the Gulf, proposed to meet her there by sending a French consular agent "to open a register of French *protégés* for all that region." Two years later a French consular agent was accredited to Muscat; the register recommended by M. Deloncle has been opened, and Arabs with slaving propensities have freely resorted to registration as French *protégés*, in order to avoid search and detention by British ships of war.

NAVAL SERVICE IN THE GULF.

The work of policemen of the Gulf may be less arduous now than it was in the old days, but the spirit of piracy is latent, and a break in the continuity of British vigilance would be followed by a return of the old disorders. The beneficial effects of our past policy in this regard are frequently seen in the manumission at the Consulate of Muscat of slaves claiming their freedom under Sir Bartle Frere's Treaty, and there is but one opinion as to what the result of slackened vigilance on the part of British naval officers in the Gulf would be.

There is yet another service which England has rendered to civilisation in the Persian Gulf—the survey of its coasts and waters. This was systematically commenced in 1789 by officers of the old Indian Navy, who surveyed the Gulf and the Shat-el-Arab as far as Bussorah, as well as the coast near Muscat. The work seems then to have been suspended, but it was taken up again in 1820, and was continued without interruption for nine years. Every officer engaged in it broke down, Lieut. Low tells us—a fact which will surprise no one who knows the climatic conditions under which naval service in the Gulf is performed. Things have, let us hope, improved since the time when eight commodores in succession had to be appointed in fifteen years to the command of the Gulf station—serving on the average a little over half the regulation period of three years—of whom four died at their posts, while four-fifths of the officers had to take sick leave. In this connection I should like to refer to a question that has lately been discussed with some seriousness in India, namely, the health of British seamen engaged in His Majesty's ships in the Gulf. The matter is of some importance, seeing that in consequence of recent developments our naval strength there is greater than it had been accustomed to be for many years. In 1900-01, for instance, no fewer than nine vessels of the navy, including the flagship of the East Indies squadron, visited Muscat and the Gulf. Only a portion of these remain through the hot weather, but upon the remnant the strain is severe. Beri beri has broken out among crew after crew, and only a few weeks ago I am informed a gunboat took to Bombay "a shipload of sick people, men and officers." It has been suggested that the Gulf, under present conditions of service, takes too heavy a toll of our sailors; that the vessels sent there should accordingly be specially equipped for a climate which for at least two months in the year is terrible, and that the men themselves should be specially selected, while reliefs should be more frequent than they are. I need carry the subject no further. I have named it mainly because it illustrates the costliness, not by any means in money alone, of the service by which England has acquired the burdensome but beneficent position which she holds in the Gulf. It is in virtue of that position, we must suppose, that she is called upon to organise and control, through the Residency surgeon at Bushire, the sanitary service of the Gulf—an undertaking which falls as naturally in her day's work as the patrolling of the Shat-el-Arab by a gun-boat during the date season. To judge, by the way, by the number of Russians, reputed to be plague doctors, who have at odd times been seen about the Gulf recently—notably, we are told, on the island of Ormuz and Kishm—the Russian Government would seem to be peculiarly anxious to share in this work. A quite different interpretation, however, has been placed upon the fact by people sceptical as to the purely scientific aims of Russian scientific missions.

In one other noteworthy respect England has contributed in a very substantial degree to the peace of the Gulf and the countries adjacent—I mean in the help which her representatives have given to the repression of the trade in arms. The evil of an uncontrolled inflow of rifles amongst a population who were steadily getting out of hand was too long tolerated by the Persian authorities, but when once the Government at Teheran decided that their own orders in this regard should be carried out, they met with the cordial co-operation of the British political and naval authorities at Bushire and Muscat. It is satisfactory to know that the English law courts have emphatically endorsed the action of our representative in the Gulf, which, however harshly it may bear upon individual traders, has made for tranquillity, and has been in essential consistency with England's traditional rôle.

The Opening of the Karun River.

The briefest reference must suffice to England's service to civilization in bringing about, after prolonged efforts, the opening of the River Karun to foreign navigation. The importance of her success was, it may be, exaggerated at the time, for the value of the Karun as a trade-waterway is largely contingent upon the opening up of safe and viable connecting roads through a difficult and frequently unsafe country. But the mule-road from Ahwaz—the point at which the river course is broken by rapids—to Ispahan, which has been constructed through the enterprise of Messrs. Lynch, is now open, and Mr. Joseph Walton, the member for Barnsley, who has done much to keep British interests in Persia and China in the view of Parliament, told the House the other day that he had performed the journey in 15 days, a considerable saving on the old Shiraz-Bushire route. The consular reports show that the new route has already led to an increase of trade, and that certain products have for the first time, by its means, been brought down to the Gulf for exportation. The point on which I would lay stress in this connection is that whereas when France, in the late seventies, was seeking for a concession for the irrigation of the plain through which the Karun runs, she stipulated for the exclusive right of navigation on the river, England asked for no special right. We are on the same footing there as every one of our neighbours.

BRITISH TRADE IN THE GULF.

This rapid survey of the events by which England has arrived at her present position in the Gulf, and of the work which she has performed there, certainly affords no encouragement to those who have lately urged that she should abdicate that position to the advantage of another Power. While it is certain that the efforts and sacrifices which England has made in the Gulf have not been repaid to her in pounds, shillings and pence, she has nevertheless attained an advantageous commercial position there which she would be foolish to surrender to a competitor, whose recent attempts to bring about alterations in the Persian tariff, obviously intended to exclude British and Indian trade, and correspondingly to favour Russian, should warn us what the result to our trade would be if she were ever to attain a predominating position on the Gulf. The facts are familiar, and they need only be presented in summary form. In 1900, 321 out of 327 steamers that entered the Gulf ports were British; of the whole tonnage, 408,000 out of 508,000 tons were British. No Russian trading ship showed itself inside Cape Musandim, or near it, and although, last year, the *Korniloff* made two voyages, under a subsidy, from Odessa to the Gulf ports, she carried quarter cargoes, and got rid of them at a loss. France, also was unrepresented in the steam shipping of the Gulf, and the tricolour scarcely covered two thousand tons of sailing shipping there, notwithstanding her recent anxiety to show her flag in those parts, in the years 1899 and 1900. In the trade itself, the preponderance of the British element was almost as marked as in the shipping. In over £2,000,000 worth of exports, the United Kingdom and India stood for nearly half; while over a million and three-quarters represents England and India's contribution to the £2,873,000 worth of imports in 1900. The trade of the Gulf, then, is essentially British, and our monopoly, if such it may be called, has been acquired through no policy of selfish exclusiveness, but by what I may venture to call commonplace shopkeeping enterprise. Forty years ago, the business-like instincts of the founders of the British India Steam Navigation Company led them to make an experiment with a regular steam service between Bombay and the Gulf, and though they have competitors, it is under the British flag that their rivals ply, not even the extravagant subsidies voted by the French Chamber having sufficed to keep a French line afloat in the Gulf. Other nations have threatened from time to time to try their fortune in these waters, but thus far the Odessa experiment has been the most pretentious, if not the most discouraging, amongst them.

The virtual non-existence of Russian commercial interests in the Gulf is a fact to which strangely little attention has been paid by the advocates of what is vaguely called a concession to that Power in the Gulf. As the purpose of this paper is to deal rather with facts concerning the Gulf, than with speculations, little shall be said as to projects for railway extension in that direction which are attributed to Russia. Still less free am I to deal now with German projects for a railway to the head of the Gulf. But if the former projects have any real existence, it is obvious than they cannot be considered apart from the facts:—(1) That although Odessa is little more than half as far from the Gulf as the British ports, Russia has, despite a liberal system of subsidies, failed to obtain any portion of the trade of the Gulf; (2) that a railway to the Gulf from any portion of the Trans-Caspian line would involve infinitely more costly means of transit than the sea route; (3) that the Gulf is not a natural commercial outlet for the products of the region traversed by the Trans-Caspian line; (4) that such a line would run through a country presenting considerable physical obstacles, and would, broadly speaking, be undertaken in defiance of the ordinary commercial and financial incentives to railway construction.

THE INDIAN FACTOR IN THE GULF PROBLEM.

These are the facts, no matter whether Bunder Abbas—which is forbiddingly hot, and supplies no deep water anchorage nearer than four miles from the shore—or some other port be chosen. If the inference that is drawn from them should be that Russia's object in seeking for railway communication with the Gulf is a political and strategical rather than a commercial one, then we have pressed upon us in a peremptory fashion the Indian factor in the problem of the Persian Gulf—a factor which, as has been shown, has been more or less efficient at intervals during the greater part of three centuries, and the responsibilities arising out of which England and her agents in the East have borne at a great price. If Captain Mahan and other eminent expert authorities are right in their belief that with Russia installed in the Gulf our communication with India would be threatened and our hold upon the country compromised, the Imperial importance of the question cannot be gainsaid. Even if a less serious view be taken of the contingency—and statesmen slow to distrust Russia are as sceptical of her ever menacing India from the Gulf as they are of her ever threatening her land frontier—we should still have to ask whether a defensive system adapted to the requirements of the present would suffice for the new strategical conditions which her presence in the Gulf would bring into being. Just as the gradual approach of Russia towards the Afghan frontier has compelled us to increase our fortifications and land forces, so her appearance in the Gulf, whether as owner in sovereign right of some port or island, or as lessee of some maritime terminus of a railway joined to her Trans-Caspian line, would involve a large and costly recasting of our naval resources in Indian waters. This would be a measure, not of panic, but of necessity and common prudence, and those who are jealous of any addition to the charges upon the Indian taxpayer would do well to realise that this question has an important bearing upon the finances of India in the future. This is one reason why in carrying out their policy the British Government would do well to give the fullest weight to such promptings as may reach them from India. I would urge this for the additional reason, not that there happens to be at the head of the Indian Government at this moment a statesman full primed with knowledge of this question, but because normally the Indian Foreign Office is ever on the alert in regard to it, and has more expert knowledge within its near reach concerning it than the authorities in this country are believed to possess. And lastly the inception of British policy towards the Gulf, and its prosecution through long years of stress and peril, rested with the courageous men who, from the "Presidencies" at Surat and at Bombay, saw what the Gulf meant to England, and knew how to safeguard her interests there, and to make her flag the symbol, not only of her power, but of her peace. We know how it was said that Rienzi and his fellows mistook the souvenirs of Rome for hopes. No such charge will be brought against the Englishmen who hear in the memories of what England has done in and for the Gulf a call to a continued discharge of the old duties, and a quietly persevering assertion of the rights arising out of them.

DISCUSSION.

The CHAIRMAN said that the meeting had followed the reading of the paper with unflagging interest. It was upon a subject the opportuneness of which, and the direct bearing of which upon contemporary international politics, could not be gainsaid. Mr. Bennett had handled the many-sided historical aspects of the subject with tact and circumspection, and had avoided all acute controversial topics, more especially those relating to friendly powers. Still, the paper had lost none of its savour or interest on that account, or that instruction which the facts and concatenation of the events to which he alluded were so admirably designed to convey. They knew, as Mr. Bennett reminded them, that the guidance of Indian foreign affairs lay with the Viceroy, than whom no one was more fitted to safeguard the secular interests of Great Britain and of India against both the overt and the covert attacks which were sometimes to be apprehended in the domain of Persian politics. No one was so well able to give to the policy of Great Britain a sound and sensible orientation as Lord Curzon was, for he had made the subject a study of his own. Lord Curzon's conclusions had been enshrined in a book which had become a standard work, and which Mr. Bennett had aptly described as monumental. In the pre-Curzon days there was not observable the same policy of firmness blended with a certain admixture of conciliation which was observable now. At one time the first quality prevailed, and at another time the second quality kicked the beam, and then occurred what was known in medical language as a solution of continuity; and in Oriental countries, whenever a variation occurred in the trend and policy of a country, it was at once pounced upon and taken advantage of, and then the ambitions of foreign powers were pushed forward and pushed home. Not only so, but any such variation had the unfortunate effect of reverberating by its reflex action, and leavening the policy of our rulers at home. It was very much to the credit of the Indian Press that they had taken care to call public attention to any vacillation, or to any policy of drift and of temporising, and to the disasters which were likely to occur from perseverance in a policy of that kind. They had been glad to hear from the reader of the paper that the present Government, at least, need not be placed in any such pillory. As Mr. Bennett had remarked, there was a very interesting debate in the House of Commons two or three months back, which showed that the members of His Majesty's Government were alive to the possibilities of the situation. In the course of that debate, a most able and powerful contribution was made by Earl Percy, whose unavoidable absence from this meeting they all regretted. In connection with the reference which Mr. Bennett had made to Bunder Abbas, a story was told by Lord Percy to show the caloric qualities of that place. It was said that an old sheikh, who had lived at Bunder Abbas, died, and was supposed to have gone to a place which was not very cold; but, in spite of that, he had to send back to this world for his blankets. The value of a paper like the present could not be gauged by any immediate advantages, but it was valuable on account of the information which it afforded to the public mind with regard to the bases of our political and material wardenship of the Persian Gulf. That was a wardenship which, as Mr. Bennett had said, involved the successful grappling with the blighting and enthralling institution of slavery, and involved the eradication of piracy as well as the policing of the waters of the Gulf, to the advantage not only of British traders but of all the traders of other nations, and those traders had fully availed themselves of the *pax Britannica.* The paper would enable the public at home to understand the elements of the Persian Gulf question, and the hands of the Government were considerably strengthened when the national mind was fully informed. In this way the paper possessed an educational character of great value. Mr. Bennett had dealt in a masterly manner with the steady advances of foreign powers. The point was not what those powers had actually succeeded in obtaining in Persia, but it was their buzzing round about that kingdom and the constant aims and aspirations which they thus revealed. Those matters afforded food for reflection. In dealing with this point Mr. Bennett had avoided being drawn into the vortex of controversial politics. They all knew that any disturbance in the balance of power in Persia would constitute a menace of a very grave character to our great Indian dependency, because it would involve a continued jeopardy to the whole of the western littoral of India. The security of the Persian Gulf was as essential to the peace and security of India as the security of Ireland was to Englishmen at home. If a simmering of disaffection was kept up upon our flank, which of course was the whole of the Persian Gulf, and any disturbance broke out in Afghanistan that disturbance would be reflected through the length and breadth of India; and it must not be forgotten that the Russians had been making efforts to get a foothold. France was sending boats to Muscat and Germany was bringing a railway through Asia Minor to Koweit. There had been troubles and a recrudescence of troubles at Koweit, believed to have been commenced by Turkish intrigue. All these enterprises converged round about the Persian territory. The man in the street was naturally driven to inquire what could be the meaning of all these simultaneous enterprises. One naturally asked what the English position would be in Persia if the power of that country to resist attacks became crippled and neutralised by foreign influences. We could all see that the valley of the Karun, the only navigable river in Persia, should be kept free for the trade of the world, British institutions upheld, and the Consular staff considerably strengthened.

Mr. JOSEPH WALTON, M.P., said that he had always considered the Persian question one of first-rate importance, and, in consequence of that, and largely by the advice of Lord Curzon, he spent the last Parliamentary recess in journeying through Persia and Baluchistan. He entered Persia from the Caspian Sea, and went down to Teheran, and then to Ispahan. From Ispahan he crossed by caravan to Ahwaz on the Karun, descended that river to the Persian Gulf, and as the reader of the paper had told them, traversed the distance in fifteen days. The climate was perfect, and the journey delightful. He afterwards coasted down the Persian Gulf, calling at Bushire, Bunder Abbas, Muscat, and other ports. He then entered India, and went to Quetta for the purpose of getting information from the Indian side about the new Quetta-Nushki trade route leading into Persia. He was sorry to say that efforts were being made to hinder our free trading by that route. He hoped that His Majesty's Government would take care that the facilities for British and Indian traders were fully maintained. With regard to Persia, the situation was that we had a definite understanding with Russia for guaranteeing the independence and integrity of the country, as a whole. That had been confirmed from time to time, during the last two or three generations, but, whereas fifty years ago we did a very important trade with Northern Persia under the treaty of Berlin, Russia had Batoum and Kars ceded to her, and now puts her full protective duties even on British goods in transit to Persia, and, therefore, British trade with Northern Persia was very much diminished. On the other hand, Great Britain had at an enormous cost, not only of money, but of life, policed the Persian Gulf for generations for the benefit of all nations equally. As to the Caspian Sea, it was to-day absolutely a Russian preserve, and no flag but the Russian flag was allowed to float on its waters. That being so, it behoved Great Britain to uphold all the more strenuously at least equal rights and interests, commercial and political, in Southern Persia, because the coast of Persia was adjacent to the coast line of our great Indian Empire. He did not agree that Bunder Abbas was not a magnificent harbour. There was a deep water, sixteen miles by thirty, and the harbour would make one of the strongest naval bases which any power could have. It had been made clear in the paper that if Russia came down by railway into Persia, she would come for political and not for commercial reasons. If Russia established a naval base on the Persian Gulf, it would inevitably mean an enormous increase in our naval and military force for the proper defence of our Indian Empire. The question, therefore, was a vital one. He was glad to admit that the Government were at last wide awake to the importance of it. If they had been awake to it earlier they would not have allowed the Persian loan of two and a-half millions to fall through, but would have guaranteed it, and, instead of impecunious Persia being in the hands of Russia, it would have been in the hands of the British Government. If a fresh loan was made by Russia, England would have to take care that Russia did not get as a security the receipts of the ports of the Persian Gulf. Russia had recently advanced another million of money, but he did not know on what terms. There was great reason for the English Government and the Indian Government being very vigilant with regard to what was going on between Russia and Persia. Russia, without the slightest hesitation, had built three military and commercial roads down into Northern Persia, and England ought to have acted in a similar way with regard to Southern Persia, in order to strengthen her position there. He had pressed upon His Majesty's Government that England should give some financial assistance, in order that the Karun River and the caravan route to Ispahan should be backed and developed, and thus increase the facilities for promoting English trade in the interior of Persia. But that would not be sufficient. We also needed a road from Bunder Abbas by Kerman to Ispahan; and we ought to develop in every possible way the Quetta-Nushki trade route. England had not sought any exclusive advantage in anything that she had done in Southern Persia. Our policy was "Persia for the Persians, and an equal right for all other nations to trade there." The policy of England in Persia was equitable and unaggressive, and no one had any right to complain of it. He congratulated Mr. Bennett on his most excellent and instructive paper.

Major P. Molesworth Sykes said that he did not think that people, generally speaking, knew how small and how difficult was the beginning of our trade with Persia. The pioneer effort was made early in the 17th century, because the British factors at Surat could not dispose of the five or six shiploads of cargo which their fleet had brought, and consequently despatched a vessel to Jásk to try and open up trade with Persia. With regard to the Persian Gulf to-day, he could endorse particularly what Mr. Bennett had said about the harm which was done by the trade in firearms. If they wanted to do harm let them give firearms to a wild man. If they wanted to kill trade, let them trade in arms. Half-a-dozen men with modern weapons of precision could close almost any trade route; as, if they were attacked, they could clear away, like the Boers, and come back again when their opponents had quitted the district. As to the climate of the Persian Gulf, it was described in very vigorous English in Queen Elizabeth's time in a book called "Purchas his Pilgrims." Indeed, there was no place that he would sooner live out of than Bandar Abbás. To-day peace was everywhere in the Gulf. Hindustani was the language of the ports and trade was flourishing; but, if the English gunboats were to leave for a month, piracy would again raise its head. He joined in thanking Mr. Bennett for his paper. He had gained more information about the Gulf from Mr. Bennett's journal than from any other newspaper that he had ever read.

Sir George Birdwood, K.C.I.E., C.S.I., said he had no claim to speak on the subject under discussion, except his friendship for Mr. Bennett, which had grown out of his own intimate connection with the *Times of India*, when that newspaper was first founded by his dear friend the late Robert Knight, —who first made the press a political power in India, —in partnership with the late Matthias Mull. He had indeed served in the Persian Gulf as medical officer of the late Honourable East India Company's s.s. *Ajdaha*, in 1856-7; and, after the untiring witchery of its dream-like shores of ever-changing form and colour, what most attracted his observation was the wonderful command possessed by the officers of the Indian Navy of its navigation, and over the littoral tribes on both its Persian and Arabian shores, and the desire of the people everywhere to be brought within the strong, well-ordered, and peaceful pale of settled British rule. The Company's officers carried their ships in and out of the ports in the Gulf as familiarly as the watermen of London Bridge rowed about among the wharves of the Thames: and wherever they went, from the youngest middy to the commander, they were received as personal friends, and natural rulers, and by sheer weight of their character for truthfulness, fair dealing, and fearless courage. In a word, down to 1856-57 our authority in the Gulf was supreme, and amounted to virtual sovereignty; and it was humiliating in the extreme, and unendurably exasperating, to contrast our paramount position in the Gulf at that time with the impotent position into which it was allowed thereafter gradually to sink until the year 1900, when it at last reached,—let us hope it reached,—its *nadir*. And how was the disastrous change brought about? Simply, in the first instance, by the abolition of the Indian Navy, in deference to Sir Charles Trevelyan, who found, in striking his famous "balance-sheet," its cost an "insoluble quantity" and who was at that date popularly reputed to have had in this suicidal measure, the support, both indirect, through Sir William Mansfield, and direct, of Mr. Gladstone, the sinister influence of whose Titanic personality was already becoming more and more felt in our international policy, even under such patriotic Prime Ministers as Lord Palmerston and Earl Russell. The sudden transfer of the police of the Persian Gulf from the Indian to the Royal Navy was the beginning of our subsequent complications and troubles there; and these were afterwards all greatly aggravated by the transfer of the control of our Mission at Teheran from the Indian to the Imperial Foreign Office at Downing-street. That was why he could not unreservedly agree with their distinguished Chairman when he asked us to trust to the Imperial Government to do their duty in the Persian Gulf. He implicitly trusted the Indian Government, and the India Office, and our Ministers at Teheran, but he had no faith, apart from one or two individual members of it, in the Imperial Government, which in its attitude, during the past thirty years, toward the "Eastern Question," whether at Constantinople, Teheran, Bangkok, or Pekin, Sir Robert Morier, in a letter printed in Mr. Sutherland Edwards's "Career and Correspondence of Sir William White," recently published by Murray, had pertinently personified as "a Philistine carrying a blunderbuss loaded with cow-dung." Throughout the past thirty, and in colonial matters fifty years, the Imperial Government, except in the case of the Earl of Beaconsfield and the present Colonial Minister, had showed themselves utterly wanting in Imperial initiative, and the true Imperial spirit; and it was only when the nation had been roused to frenzy by a succession of untoward disasters and base surrenders, that the Imperial Government had at last been made to "wake up" to its responsibilities toward the world-wide colonisation, and conquest, and industry, and trade, and commerce of the Empire. The great improvement, that is to say, the comparatively great improvement, of our relations with Persia during the past year or two, has undoubtedly to be gratefully acknowledged. We must trace as latent in it the alert and resolute lead of Lord Curzon of Kedleston, at Calcutta, and the refined diplomatic sleight—as firm as it is artistic—of Lord Lansdowne in Downing-street; but the salient watchfulness and activity, and the strenuous and untiring alarms of the *Times of India*, continued through several years past, had educated public opinion, both in India and the United Kingdom, and throughout the Imperial Dominions beyond seas, as to the deadly dangers towards which we were drifting in the Persian Gulf. There was an end now to the customary instructions given to our Ministers to Persia, down to so late a date as 1900, "to raise no questions at Teheran;" and with this there would be an end, he hoped now for ever, to all the intrigues on the part of other European Powers to undermine our position of natural and inevitable suzerainty in the "Green Sea," or Persian Gulf. Germany wanted nothing more than that we should keep "the open door" there to the commerce of the world, as against Russia, who would close it. Let i not be forgotten either that Karak and Bassadu still remained British possessions. He desired to add that he felt under a double debt to Mr Bennett for the masterful paper he had just read before them, for it was owing to his personal persistence with Mr. Bennett, on behalf of Sir Steuar Bayley, the Chairman of the Indian Section of the Society of Arts, that he (Mr. Bennett) had consented to prepare his paper; and it was particularly gratifying to him to find that, beside himself, there were present to support Mr. Bennett, two other gentlemen intimately connected, in other days, with the *Times of India*, namely, Mr. Martin Wood, who was Editor of the paper when they were together in Bombay, in far,—far-off years, and Mr. Samuel Digby, who was for six years, sub-Editor, and subsequently Assistant Editor of the paper. Another source of gratification to him, and he was sure to all present, was in the happy circumstance that Sir Edward Sassoon, who had made a special study of the commercial and general economic aspects of the "Eastern Question," had filled the Chair that afternoon, and with all the personal authority, grace, and distinction we have been accustomed in Bombay to associate for three generations with the illustrious name he bears.

Sir LEPEL GRIFFIN, K.C.S.I., added his tribute of thanks and admiration to Mr. Bennett for the paper which with so much discretion he had read to them, but thought he had confined himself even too closely to the traditions of that august Society with regard to the exclusion of politics. A very large part of English predominance in the East and of our hold on India depended on the manner in which the question of the Persian Gulf was dealt with by the English Government. He agreed with Sir George Birdwood that the only thing which would induce our Government to deal with Persia in the proper way was a strong expression of opinion. He had been connected with Persia for a good many years, and he must say that, until Lord Lansdowne arrived at the Foreign Office, the policy of the British Government with regard to Persia had been one of *laissez-faire*. In the past the English Government would never give money or help either merchants or officials, but he rejoiced to say that thanks to Lord Lansdowne, a new *régime* had commenced, and he looked forward to an increase of English influence in the Persian Gulf. A great many of the questions connected with the subject could only be determined in a country like England by their financial value. It would be impossible to persuade the English Government to make roads and build railways if there was no direct commercial advantage to be gained by them. Russia, on the other hand, would develop railways for political purposes when there was no prospect of their yielding a rouble of dividend. Russian railways were, in fact, made in order to enable Russia to obtain influence. The

Persian Gulf was really the key to India to-day. India was practically invulnerable against land attacks.

Mr. H. F. B. LYNCH thought Sir Lepel Griffin had struck the right note in saying that it was impossible to deal with a subject like this, and avoid its political side. England had been invited to fold her arms while Russia was coming down to the Persian Gulf. He thought that the Society might congratulate itself upon having such a paper as that which Mr. Bennett had read to them. No one deserved greater credit for bringing this subject into prominence than Mr. Joseph Walton, who had had the honour of initiating in the House of Commons, what he (Mr. Lynch) believed was the first debate that had ever occurred there upon Persian affairs. That debate was one which redounded to the credit of Parliament, and made one feel proud of the House as an Imperial assembly. Although very few members were personally acquainted with the subject, yet by its appreciation of what took place, the House presented an admirable example of what an imperial assembly ought to be. It seemed to him that we really must give up the idea of confining our attention to the Suez Canal in connection with our Indian Empire. What we had to do now, was to make a trade route from the Mediterranean to the Persian Gulf. That subject had recently been very forcibly dealt with by Captain Mahan, who had expressed the opinion that it was of immense importance that the Persian Gulf should be kept open at all hazards, as a trade communication to India and the Far East, for all the world. What ought to be secured was a great trunk line from the Mediterranean, and caravan routes followed by railways from the south to the north. Only by moving forward, first by caravan routes, and then by railways developed on scientific principles, should we be able to preserve our influence in the East.

Captain A. W. STIFFE (late R.I.M.) said that the paper to which they had listened had been of such an exhaustive nature that it was difficult to add anything. The first appearance of the English in the Persian Gulf was of comparatively recent date, namely, 1583. They approached the Gulf overland, and the Portuguese who held the Gulf at that time acted in a very highhanded manner towards them, seizing the first visitors and taking them off as prisoners to Goa. A similar fate befell some Englishmen who visited the Gulf subsequently. The Portuguese were in 1620 engaged by an English fleet of merchantmen on the Gulf and beaten. There was one point which might have been more fully alluded to in the paper and that was the value of the telegraph in the Persian Gulf. In 1864 he assisted in laying a telegraph cable there, and he thought that the influence of our present officials at the different cable stations on the Gulf and up through Persia to Teheran had been very beneficial. There was no doubt that the Persians liked the English people, and believed that what they said was true and that what they promised would be carried out. English influence in Persia was, he believed, very great. The climate of the Persian Gulf was very much against us, and, as had been said, Bunder Abbas was a dreadful place in the summer and reputed very unhealthy.

Mr. W. MARTIN WOOD said that it was exceedingly appropriate that the editor of a Bombay paper should bring this subject forward, because the port of Bombay and the Bombay Government were the very bases of all our influence in the region of the Persian Gulf. The weakness of our position on the political side, and as regards control on and supervision of the Gulf, if such weakness existed, was due to the removal of the oversight of the Bombay Government by the Political Department at Simla. Then the fact of the Foreign Office here having superseded the influence of the Indian Government; together with the extinction of the Indian Navy, and absence of its officers from all the Arabian shores, was the chief cause of the confusion and muddle which now obtained.

Mr. J. D. REES, C.I.E., said that everybody who wished to have a knowledge of Persia ought to read not only the valuable letters edited by Mr. Foster, to which reference had been made, but also Morier's Hajji Baba and Major Sykes's new book. Reference had been made to the relative importance of the Persian Gulf and the northern frontier of India. He (Mr. Rees) believed that the Persian Gulf was the more important point as regarded the safety of India. Mr. Joseph Walton had referred to the making of roads by Russia down towards Teheran. We ought to remember that the nation which spent its money so freely on strategic roads had at present to deal with a revolted peasantry, and probably the internal condition of that country was much less satisfactory than that of England, a country which looked upon every pound it spent, or at any rate did in former days.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Bennett.

Mr. BENNETT, in reply, said that he had come from India with his mind charged with convictions on the subject of which he had treated, and he was anxious for an opportunity of giving expression to them. The Society of Arts had given him that opportunity, and the obligation for giving thanks was rather upon him than upon the meeting. He was more than repaid for the preparation of the paper by the fact that it had evoked a discussion by an array of men, most of whom had far larger claims than he had to be regarded as experts on the subject. The discussion had been important and valuable. It had been a great advantage to him that they had had, as Chairman of the meeting, not only the representative of an honoured family in Bombay, but of a family whose connection with the Persian Gulf had been long and close; and in the personality of the Chairman they had one who had done enormous good to India, and successfully fought the battle of cheap telegraphs.

Obituary.

Sir Daniel Cooper, Bart., G.C.M.G.—Sir Daniel Cooper, the eminent Australian statesman, died at his residence, 6, De Vere-gardens, on Saturday, 5th inst. He was born at Bolton-le-Moors, July, 1821, the second son of Mr. Thomas Cooper, merchant, and was educated at University College, London. He emigrated to Australia in 1843, and at the age of 28 he was elected to the Legislative Council of New South Wales. After the grant of responsible government to the Colony, he was chosen first Speaker of the Legislative Assembly. In 1861 he returned to England, and during the Crimean War and the Lancashire cotton famine, he took an active part in the promotion of the fund in Australia for the relief of the sufferers, and for this and other public services he was knighted in 1857, created a baronet in 1863, and received the K.C.M.G. in 1880, and G.C.M.G. in 1886. He acted on several occasions as Agent-General for New South Wales, and was a member of the Royal Commission for the Colonial and Indian Exhibition in 1886. Sir Daniel Cooper was elected a member of the Society of Arts in 1862, and served on the Council in 1867-68. He was also Vice-President from 1869 to 1874, in 1882, and from 1887 to 1890. He presided at evening meetings on several occasions when Colonial matters were discussed. In 1881 the Council offered silver medals for the best sanitary arrangements in houses within the metropolitan area, and in the following year a medal was awarded to Sir David Cooper for the arrangements of his house in De Vere-gardens.

William Bull, F.L.S.—Mr. William Bull, the well-known nurseryman and new and rare plant merchant of King's-road, Chelsea, died at his residence on Sunday, 1st inst., after a few days illness, at the age of 74. He was a native of Winchester, and at the age of 14 his natural bent for floriculture led to his being apprenticed to a nurseryman in his native town. He was subsequently employed successively by Messrs. E. G. Henderson and Son, of St. John's-wood, and Messrs. William Rollisson and Sons, of Tooting. In 1861 he took over the premises and nursery stock of Messrs. John Weeks and Co., of the King's-road, and founded his famous establishment for new and rare plants. He despatched eminent botanists to all parts of the world in search of rare plants, and he made the collection of orchids a speciality of his establishment. Mr. Bull was elected a member of the Society of Arts in 1874.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 16...Sanitary Engineers, Town-hall, Buxton (Summer Meeting), 10½ a.m. Mr. W. H. Grieves, "The Public Works of Buxton."

Tuesday, June 17...Sanitary Engineers, Town-hall, Buxton, 10½ a.m. Mr. E. Durant Cecil, "Proposals for Modern Bye-Laws for Rural Districts."

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. T. A. Welton, "A Study of some portions of the Census of London of 1901."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Walter Kidd, "Certain Habits of Animals traced in the Arrangement of their Hair." 2. Mr. F. E. Beddard, "The Carpal Organ in the Female *Hapalemur griseus.*" 3. Mr. R. I. Pocock, "Some Points in the Anatomy of the Alimentary and Nervous Systems of the Pedipalpi."

Wednesday, June 18...Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. F. Campbell Bayard, English Climatology, 1891-1900." 2. Mr. W. L. Dallas, "Earth Temperatures Recorded in Upper India."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. C. F. Rousselet, "The Genus Synchæta. A Monographic Study with Descriptions of Five new Species."

Thursday, June 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. W. G. Ridewood, "Obesiella, a new genus of Copepoda." 2. Mr. G. Masseo, "Modern Methods in Mycology." 3. Mr. W. P. Pycraft, "Further Observations on the Owl, especially their Skeleton."

Chemical, Burlington-house, W., 5½ p.m. 1. Messrs. R. Meldola and J. V. Eyre, "Elimination of a Nitro-group on Diazotisation. Dinitro-p-anisidine." 2. Mr. F. D. Chattaway, "A new type of Substituted Nitrogen Chlorides." 3. Messrs. F. G. Donnan and H. Bassett, jun., "The Colour-changes exhibited by the Chlorides of Cobalt and some other Metals, from the standpoint of the theory of Electro-affinity." 4. Mr. B. D. Steele, "An accurate method of Determining the Compressibility of Vapours." 5. Mr. H. S. Shelton, "The Molecular Condition of Borax in Solution." 6. Messrs. W. A. Tilden and H. Burrows, "Preliminary notice of some new Derivatives of Pinene and other Tarpenes." 7. Messrs. J. W. Mellor and E. J. Russell, "The Preparation of Pure Chlorine and its behaviour towards Hydrogen."

Historical, Clifford's-inn, Fleet-street, E.C., 5 p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m. Annual Meeting.

Institution of Mining and Metallurgy, (at the Rooms of the Geological Society, Burlington-house, W.), 5 p.m. 1. Mr. Herbert C. Hoover, "The Kaiping Coal Mines and Coal Field, Chihle Province, North China." 2. Mr. H. Livingston Sulman, "A Dry Process for the Treatment of complex Sulphide Ores." 3. Mr. Hans C. Knutsen, "The 'Diehl' Process." 4. Mr. Mervyn S. Stutchbury "The Pierrefitte Concentration Mill."

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FRIDAY, JUNE 20, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

THE ALBERT MEDAL.

The Albert Medal for the year has, with the approval of His Royal Highness the Prince of Wales, President of the Society, been awarded to Professor Alexander Graham Bell, "for his invention of the Telephone."

CONVERSAZIONE.

The Society's Conversazione will be held, by arrangement with the Council of the Royal Botanic Society, in the Gardens of that Society, Inner Circle, Regent's-park, on Tuesday evening, June 24th, from 8.30 to 12 o'clock. The reception by Sir William Preece, K.C.B., F.R.S., Chairman, and the other members of the Council, will be held at the entrance to the Conservatory, near the Broad Walk, from 9 to 10 o'clock.

Two entrances to the Gardens will be used. The principal entrance faces the road leading to York-gate and St. Marylebone Church. It is less than half-a-mile from Baker-street Station, on the Metropolitan Railway. The second entrance is on the North side of the Gardens, near the road leading to Chester-terrace, and the east side of Regent's-park. A covered way leads from this into the Conservatory.

The central portion of the Gardens only will be used. The Gardens will be illuminated with coloured lamps, and also by the Kitson Incandescent Oil Light.

The Conservatory and Club House will be open.

The Royal Botanic Society's Exhibition of Rhododendrons will be on view, and there will be a special exhibition of roses and growing and cut flowers by Messrs. W. Paul and Son of Waltham Cross.

A selection of music will be performed by the String Band of the Royal Artillery in the Conservatory, and by the Band of the Scots Guards in the Gardens, commencing at 9 o'clock. The Red Hungarian Band will also play at intervals in the Gardens and in the Club-house.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These cards are now issued. In addition a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the Conversazione. On that day the price will be raised to 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

The Council reserve the right of stopping the sale of tickets, or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill Prize of £50 and a Silver Medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges no paper deserving the full award is sent in.

APPLIED ART SECTION COMMITTEE.

A meeting of the Committee of the Applied Art Section was held on Tuesday afternoon, 17th inst. Present: Sir George Birdwood, K.C.I.E., C.S.I. (in the chair), Lewis F. Day, W. Gowland, H. H. Statham, Carmichael Thomas, and Sir Thomas Wardle, with Sir Henry Trueman Wood (Secretary of the Society), and Henry B. Wheatley (Secretary of the Section). The arrangements for next session were considered.

Proceedings of the Society.

COLONIAL SECTION.

Thursday afternoon, May 29; J. Parker Smith, M.P., in the chair.

The Chairman said that no man was more qualified to address an audience on the subject of the paper than was Mr. Venn, who was a member of the Legislative Council from 1880, a Commissioner of Public Works in the first Representative Government formed in Western Australia, and since then he had been the representative of Western Australia at the Exhibitions of Paris and Glasgow.

The paper read was—

WESTERN AUSTRALIA: ITS PROGRESS AND RESOURCES.

By the Hon. H. W. Venn.

Australia and Empire.

At a moment when the question of Empire is moving the minds not only of statesmen, but of the millions composing that Empire, it follows, in the proper relation of things, that those having experience in its distant and important sections, should endeavour to give heir fellow-subjects some definite idea of the relation those sections bear to the main subject; and when we come to deal with the progress and resources of any one State, in relation to the whole, as the future home of millions of our race, it becomes at once evident how necessary it is to deal with hard facts and hard figures. The immense and rapid progress made by the Australias, at the furthest possible distance from the Mother Country, is a remarkable testimony to the adaptability of the Englishman for any climate, under any circumstances. Coming as he does from the Northern Hemisphere, not so very far from the North Pole, inheriting from a temperate climate a hardy and vigorous constitution, and having the advantages of historic civilization and refinement as a groundwork for his action, he plants himself on the distant shores of Australia, under conditions the absolute antipodes of all to which he has been accustomed, and as a racial result you find him forging ahead at once. He brings out the surroundings of his old life in strong relief, and he starts to build up a nation in every way worthy of his race, and a counterpart of the dear old land he loves so well. The Britisher takes his birthright with him wherever he goes, and he imports a freedom, a healthiness, and robustness which is irresistible, in its political and economic effects. He plants the old flag on the new soil with the unalterable intention of maintaining its traditions and its rights; and if there is one thing above all others conspicuous in the history of Australians, it is the one standing out in the sharpest relief—they are intensely English.

I am speaking as an Australian by birth and education, who, having passed through a period of active political life, visited the Mother Country for the first time when his ideas had matured. It was an experience to find here the identical sentiments, pastimes and ambitions that move us, and the touch which makes us all feel that the bonds of family which unite us in Empire must never be severed. How this feeling has been developed and strengthened in recent years is but another evidence of the truth of these generalisations. The Australias have been gradually moving ahead for nearly a hundred years, that is, it is something over one hundred years since the first settlements of New South Wales. If the progress made for the first 30 to 40 years was slow, we must look back 120 years into the history and the population of the Mother Country. Britain in Cromwell's time had only a population of some 5,000,000, and up to 1801

England and Wales, Scotland, Ireland, and the Channel Islands numbered less than 17,000,000; therefore there was no great surplus of emigrants to be spared for the Australias from Great Britain, and it was not until the Mother Country herself made great strides in commerce, wealth, and population, that the Australias, peopled by the same race, could move ahead at all. The United States and Canada, in the meantime, being close to England, required and secured the great bulk of the migrating British people, and consequently the Australias had to make their own forward movements as best they could. But progress was made all the same, despite the enormous handicap of distance. In fact, the Australias being so far away,—a three to four months' voyage, say, less than fifty years ago,—its settlers were scarcely known to a large section of our race in the Old Country, except in a shadowy way, as colonists pursuing pastoral avocations in another hemisphere. Our gold brought us first into notice, and was the magic wand which stimulated activity and interest respecting Australasia, not only in England, but the world. But distance still retarded national progress, and I can recall the time,—not so many years ago,—when the Australias were looked upon as a drag upon the Mother Country by some of the political parties of the time, who went so far as to hint that England would be better without us. Blood and race away across those deep dark seas were factors not held very important by such politicians, and there was a lukewarmness evinced likely to have alienated the loyalty of any other race save Englishmen. But times change rapidly, our progress became more pronounced, our wealth and our possibilities gradually became recognised, and Australasia, under the magic influence of gold and the numberless products of its soil, leaped into active national life, and simultaneously with the call for nationhood came a clarion note, sharp and clear, the desire to share in the responsibilities of Empire, by sending of our best to help the old flag against oppression, and the attempted expulsion of our race from the land it had contributed so much to make. The South African war demonstrated to the Mother Country an aid upon which she had never before counted. The mantle which hung over the peaceful avocations of the past, and which had hidden an appreciative recognition, was removed. Distance for the moment was annihilated, and the Australias became known to the Mother Country with a directness not to be misunderstood. It is a long road which has no turning, and although it may be rightly assumed that the Federal movement of the Australias would have had a significant effect in drawing the attention of Great Britain and the world to their importance as a part of the Empire, there can be no doubt whatever that the war in South Africa and the part the Australias have played in assisting the Mother Country, has crystallised a sentiment, and stimulated an interest in our welfare that would not otherwise have shown itself for years. I make these general observations because, being an Australian, I think of Australia as a whole, and before I deal with the progress and resources of any one part, as that which applies to Australia as a whole, applies with equal force to any one of the new States.

FEDERATION.

I desire to sound no uncertain note on the subject of the Australias and Federation.

The baptism of federation, with our Prince and Princess of Wales at the font as sponsors, drew from nearly four million voices shouts of loyalty and devotion to that Crown all Englishmen honour; but while federation must exercise a powerful influence in our national life, there never was a time in the history of the States when they should be more actively alive to their own internal interests. The federation of the Australias was achieved slowly by resolute and capable men, as a means of centralising and instituting a higher political life, and of focussing under one dominion Government questions that would affect the Australias as a whole—questions better dealt with by a central Government, acting under the representation of the States as one body, than they would be if treated individually without cohesion. A Government in the Southern Hemisphere, that should stand out prominently to the world the embodiment of Empire, not to absorb individual States or direct their internal progression, but to be a bulwark of their liberties and their interests on those subjects relegated to them under the Constitution by the States, to help to build up Australia as a whole, without undue favour to any one part, and to assimilate and make international laws and direct the main lines to nationhood. If we ever expect the new-born Commonwealth and Dominion of Australia to become great, we must build up each State to support that Government, as its backbone—for without the force and power of prosperous States are behind the Commonwealth it cannot become great.

Many years may elapse before that consummation shall be realised—years of individual building up, of local settlement and advancement; in order that each State (recognising those rights and powers of the Commonwealth Government, cheerfully relegated by the States), may not forget its local advancement, or relegate the control of its local administration to the central body. I have said that I sound no uncertain note as to the exercise of State rights by the States Government, as, in my opinion, apathy in this respect will assuredly lead to a decentralisation of populations and manufactures that we should eventually deplore. The States must individually formulate their own schemes for the development of their own natural resources, and be keenly alive to the necessity for attracting population, and each must vie with the other in upholding the Commonwealth—all this is loyally consistent with that Constitution we formulated and gave to the Commonwealth—consistent with Empire. The provision of the Constitution rightly understood, will preserve that co-individuality — apparent in every clause—and, that being so, I again say that there never has been a stage in the history of Australia when it was more important to be active and doing in regard to State advancement. The Commonwealth Government is now in its first session, undergoing its initial experiences, and it was not to be expected that complex questions affecting the States with the loss of some of their individuality would not raise difficulties and cause friction. But these will only test our grit; and there are no troubles which cannot be overcome by Australian statesmen in the maintenance of the Commonwealth. Each year will see difficulties cleared away, and reveal the wisdom and power of Federation. The air is full of Empire, and the calls upon that Empire are as varied as they are momentous—the age is living at high pressure, under the stimulus of electric and other scientific progress—and from all portions of the globe we find active and vigorous competition against the trade and commerce of the Empire. We are no longer in undisturbed possession of our supremacy in the markets of the world, and without we awake and invest the word "empire" with its true meaning, without we protect and conserve the industries of our people, our place will be taken by other nations more alive and alert to the spirit of the times. It is an age of great combinations, great consolidations, great trusts, and to us the greatest of all combinations and trusts will be the consolidation of the British Empire.

GROWTH OF WESTERN AUSTRALIA.

Having said so much on the general question of Australia and Empire, I will now deal more particularly with the immediate title of this paper,—"Western Australia: its Progress and Resources."

As you know, Australia in size is the fifth continent in the world, but as we rarely look upon a map except to locate some part in which we are for the moment interested, I may be permitted to say that Australia is not only the fifth continent of the world, but the largest continent island in the world, containing as it does over 3,000,000 square miles of territory. I travelled the whole way round this continent in 1891, making myself acquainted with nearly every port of call, starting from Fremantle, thence north *viâ* Port Darwin, Thursday Island, Brisbane, Sydney, Melbourne, Adelaide, and completing the circuit to Fremantle. Australia, in latitude North and South, is about 1,300 miles long, and in longitude East and West 2,460 miles broad, with a total coast line of nearly 8,000 miles. Of this great continent Western Australia alone embraces one-third. Its size can probably be better gauged by saying that Western Australia contains 684,588,800 acres of territory, while the United Kingdom embraces less than 70,000,000 acres of territory. On this great unknown land of Western Australia the British flag was hoisted in Albany, December 25th, 1825; and again by Captain Fremantle on May the 2nd, 1829, at the port which still bears his name. On June 2nd, 1829, Governor Stirling landed at the same place with a small band of sixty-nine hardy settlers. This was really the beginning of permanent settlement in Western Australia. I will not dwell on those early days, interesting though they are and full of incident and quiet heroism—these events are found in many records, and those who desire to make themselves more intimately connected with the trials of the first settlers may easily do so by consulting official records. Isolated and separated as it was by thousands and thousands of miles from the Mother Country, without trade, a tiny settlement, depending entirely on the Colonial Office for everything, it can be readily understood how slow the progress was, yet, however tardily, the settlement moved a little. At first it was controlled and administered by the Governor, with an official executive; then, in 1832, the first Legislative Council came into life. In 1834 £1 notes were issued from the Commissariat office, because money in the shape of specie was conspicuously absent. After many years of hard work and determined effort further results were achieved. In 1839 there were 2,726 acres of land under cultivation; the population was 2,154 persons all told; they had 21,038 sheep and 1,308 cattle; in 1840 a vessel called *The Shepherd* sailed for London laden with colonial produce; land in 1842 sold for 1s. 10d. per acre. On the 21st anniversary of the colony the revenue reached £17,032. In 1845 sandalwood was first exported; in 1867 the pearl shell industry commenced to export, and thence gradually things moved ahead. Steam communication was established on the coast, previous to which changes of administration took place, from a purely Crown colony to a hybrid Council, partly nominated by the Crown, partly elected by the people. Then came further aspirations, and murmurs for a more responsible Government. It took many years to effect this change, the population being still very small—something under 40,000—but a spirit of unrest crept in, and stimulated by the persistent energy of a few, in 1889, a Constitution Bill was passed by the Legislature in favour of self-government, to which the Royal Assent was given on June 25th, 1890, and on December 30th a Parliament, under responsible Government, assembled, with the Hon. John Forrest as first Premier. The population was still under 50,000, but the new Constitution saw rapid changes, and a new life, for with the advent of responsible Government came the discovery of gold. Here let me give you some figures.

In 1830	the population	was	1,769
,, 1850	,,	,,	5,886—20 years.
,, 1870	,,	,,	25,084—20 ,,
,, 1890	,,	,,	46,290—20 ,,
,, 1895	,,	,,	101,143—5 ,,
,, 1900	,,	,,	179,708—5 ,,

and at this moment is something less than 200,000. You will observe that up to 1890 progress was slow, and then, how quickly the breath of life inflated the lungs of the settlement. Great strides were made; in five years the population increasing from 46,000 to 101,000, and in five years more to 180,000.

Now let us examine the outward and visible prosperity. The revenue in 1839 was £12,713.

In 1890,	the revenue	was	414,314
,, 1895	,,	,,	1,438,717
,, 1897	,,	,,	2,843,775
,, 1900-1901		,,	3,078,034

In 1889 the imports were £818,127.

In 1898 (less than 10 years) the imports were £5,241,965.

In 1889 the exports were £761,392, and in less than 10 years (1898) were £4,960,006.

These figures show that during ten years the total trade of the colony increased from £1,579,519 to £10,201,971, more than a six-fold increase, proportionately far in excess of the increase of population.

THE GOLD INDUSTRY.

Such figures, considered in relation to the population, are doubtless surprising, but are more easily understood when I quote the gold returns up to the year 1886, before which practically no gold was obtained in Western Australia. The value of the gold exported up to and in that year was as follows:—

Year.		Quantity. ozs.		Value. £.
1886	....	302	....	1,148
1887	....	4,873	....	18,517
1888	....	3,493	....	13,273
1889	....	15,493	....	58,874
1890	....	22,806	....	86,663
1891	....	30,311	....	115,182
1892	....	59,548	....	226,282
1893	....	110,891	....	421,386
1894	....	207,131	....	787,098
1895	....	231,513	....	879,749
1896	....	281,265	....	1,068,807
1897	....	674,994	....	2,564,977
1898	....	1,050,184	....	3,990,699
1899	....	1,643,877	....	6,246,733
1900	....	1,580,950	....	6,007,610

Last year the total export of the precious metal was 1,879,390 ozs., value £7,235,653.

During the 15 years ensuing from 1886 the total exports were 7,797,021 ozs., value £29,722,651.

It is a big jump in sixteen years from £1,148 to £29,722,651. This then is the magic wand which started into activity the progress of the colony between the years I have named, but you are not for a moment to infer that because gold has done, and is still doing much for Western Australia, it is its sole resource, because steady progress in other industries has been made. Our export of wool up to the end of 1901 was £7,406,036; timber, £3,403,074; mother of pearl shells, £2,236,375; sandal wood, £1,276,660; copper, £208,579; and tin, £194,231. These figures are in themselves "letters of gold," and when viewed from the incidence of a sparsely settled country should bring a glow of satisfaction to the British-speaking people, because no such results, in proportion to population, have been produced by any other people of the world. There is no mistaking their import, no mistaking the influence they should exercise on the minds of the hundreds of thousands of our race desirous of a wider sphere for their energies, than can be found in the Old Country. If these figures mean anything it is, that a country which enables a handful of people to send away 8,000,000 of gold anually, and to receive a revenue of over £3,000,000, must be a great one, and must have enormous crude resources to enable them to do it, and this is so. Let your eyes for a moment wander over the chart. You will see in latitude 15° in the North the locality of "Halls Creek," better known as the Kimberley Goldfields, right through the territory there is one continuous gold-bearing belt, down to latitude 35° in the South, the locality of the Phillips River Goldfield. There is thus a belt of 1,800 miles of gold-bearing country, certainly the most extensive gold-bearing belt the world has ever known. With this one fact before you I may well ask, what are the possibilities of the State of Western Australia? The mere fringe of this belt has only yet been touched. What can be expected from a population all told of less than 200,000, probably nearly two-thirds of whom are engaged in occupations other than gold finding?

When we think of the enormous areas yet to be examined, as compared with those areas at present slightly mined and prospected, one feels it impossible to say what the future of Western Australia will be, as mines and population increase. It may be here interesting to quote the authority of Mr. E. W. Hine, published in the Western Australian Handbook for the Paris Exhibition, as it is a comparison between the Rand of South Africa and the goldfields of Western Australia.

"It may safely be said that in point of area, of progress, and of production the Western Australian goldfields are practically without parallel in the history of mining. On many occasions the records of the Rand, the field which in some respects most closely approaches Western Australia, have been held to be unequalled; but output for output and period for period of the operations the official figures award the palm to the Cinderella of the Australian Colonies."

For the purpose of my paper I take what may be called the corresponding years of mining development in both countries although the dates differ. The Rand was the earlier of the two. In other respects the rate of progress shows that Western Australia was the greater.

The following Table, in the case of the Witwatersrand, prepared from the chronicles of the Chamber of Mines, in the case of this country from the data collected by the Customs Department, shows the gold yield of the respective countries for six years. Though set in parallel columns, the figures it will be observed are not for parallel periods. The starting point, however, is pretty nearly equivalent. The unique "banket" deposits of the Rand were found in 1885; in 1886 the big rush set in, and 1887 was the year of excitement and activity. It is from the latter year that the first records of the Witwatersrand Chamber of Mines date. In Western Australia, towards the close of 1892, Bayley and Ford unearthed a mass of yellow metal at Coolgardie, which disclosed the existence of the goldfield, and gave the first great impetus to prospecting in the colony. In 1893 came the rush; in 1894, the eastern fields were detached from Yilgarn, and declared a separate gold district. So that the periods in the lives of the two countries set in opposition as nearly as possible, correspond:—

Rand.		Western Australia.	
	ozs.		ozs.
1887	23,149	1894	207,131
1888	207,660	1895	231,572
1889	369,557	1896	281,263
1890	494,817	1897	674,987
1891	729,238	1898	1,050,183
1892	1,208,928	1899	1,643,876

OTHER MINERAL RESOURCES.

I will not pursue these points of comparison further; my object in doing so at all will be shown at a further stage of this paper, and although the one subject of the gold discoveries of Western Australia would afford matter for many papers, I will dismiss it for the moment by saying that if Western Australia had nothing whatever beyond her gold to excite recognition from the British investor, she is an important State. But she is conspicuous in other minerals, in copper, tin, lead, iron, and coal, vast resources of wealth in the active business of the world. Large deposits of copper are found on the north-west coast in the Pilbarra Goldfields, in the south at Northampton, again at Murrin Murrin — in the north Coolgardie Goldfields—and if the British investor has not yet realised the importance and value of these deposits, it arises from the fact that for the time being the glamour of gold investment has overshadowed all others. It is in the near future that Western Australia will be famous for her export of metals and minerals, but there is none that will be more conspicuous than the coal deposits of the State—for we have in them the basis of nearly every industry—coal in juxtaposition with limestone and iron; and, curiously enough, until the State was actually seized of the fact that it had gold in large quantities, it did not know that a large area of coal was lying undisturbed at its feet, near a good port (Bunbury). In fact, fortune smiled on Western Australia all round, the hidden treasures of the earth seemed revealed about the same time, for active mining for coal has only taken place during the last few years, nor can I say that up to the present moment have the deposits been more than partly prospected. Developments are, however, taking place daily, money is being invested, and active operations are converting a wilderness at the Collie into a bustling coal country.

Already there is almost an exclusive use of local coal in the colony, while less than ten years ago it was practically unknown.

The change this industry is making, situated as it is in the most fertile district of the colony, is immense. Before many years elapse the port of Bunbury will be the Newcastle of Western Australia, and, when necessity and circumstances demand, the Government will doubtless provide the money for a coal shipping harbour.

Capacity for Expansion.

In its application to Western Australia, I feel I cannot speak too forcibly on an industry which has been such an important factor in the progress of Great Britain. Western Australia, in the first place, owes her recent advancement to her gold and mineral deposits. These are, and have been, the means of attracting population, but nature did not stop there, for behind the mineral wealth of the State is a territory capable of great expansion, not a barren waste, as many mineral countries are, but a land capable of supporting millions of people. In the northern area the East and West Kimberleys are already famous for stock. There is no country in Australia better suited for producing fat cattle and sheep than are these areas, and in a similar degree this may be said of the whole belt from the Kimberleys to the North Murchison, while from Geraldton down to Albany and thence to Esperance Bay there is every imaginable climate and temperature. Than, in the south and west divisions of the colony there is no better climate in the world, with a regular and plentiful rainfall; in the eastern district it averages from 18 to 20 inches, in the southern district from 30 to 60 inches, these figures indicating a variety of climate, from exceedingly cold to mild and gentle heat. The capabilities are great. Every variety of fruit grows in the State—all the English fruits flourish luxuriantly in the open in the southern parts of the colony, while tropical fruits thrive to the north and east.

Timber.

But before I say one word more in reference to those resources of the State, let me for a moment mention one great natural resource, timber. The wooded areas are extensive, and among the most prominent of the marketable timbers there are Jarrah, Karri, Blackbutt Tuart, White Gum, and Wando, besides a variety of others, that enter into local manufactures for furniture, architectural, and art work, such as sandal wood, native pear, morrell, raspberry-jam, and others. Up to the present our principal export has been Jarrah and Karri. These enduring timbers lend themselves to any and every description of work from the homely wood paving to the highest class of carving and inlaying. They take a polish almost unsurpassable by any other hard wood except ebony and lignum vitæ, and at the recent exhibitions in Paris, Glasgow, and the Royal Exchange, the uses to which they can be put were illustrated in a variety of ways, which has stimulated active enquiry from builders, architects, and others. They are equally, if not more, durable than the oak of Old England, and richer in colouring. The result of one test made only in January last proves that Jarrah is the best fire resisting timber in the world. The tests of the Fire Prevention Society then showed that used as large girders and supports for buildings, beams carrying a load equal to 200 lbs. to the superficial foot exposed to a fierce heat of 2,500 degrees for two hours, were penetrated less than one inch, which left them practically intact. I need hard say that iron or steel girders under similar conditions would have collapsed. This interesting experiment opens out another field for the use of these timbers, and extends the already wide range of their utility.

WHEAT, &c.

I have already said that the possibilities of Western Australia, under cultivation, are great. Its wheats in the Paris Exhibition, 1900, took the Grand Prize. The production of wheat in 1889 was 504,902 bushels, in 1899 870,909 bushels, and in 1900 966,601 bushels. For the corresponding periods the following figures are interesting. In 1899, the population was 43,698, and the importation of wheat 3,083 bushels; in 1898, the population was 168,129, and the importation 56,906 bushels. In 1888, the acreage under wheat was 30,740 acres; in 1898, it was 75,032 acres. In the year 1900, the acreage under wheat cultivation was 84,462, the population 179,708, and the importation of wheat 77,375 bushels.

By these figures it will be seen that although the area under wheat is increasing rapidly, it is not in proportion to the population, and consequently the supply has partly to depend on importations from the adjacent States. The supply, however, is somewhat overtaking the demand, but while our gold and mineral deposits attract so large a proportion of the population, the wheat supply is likely to fall short of the consumption. These facts are, however, the best guarantees settlers can have for the cultivation of the soil. The consumption not yet met by the supply opens out a field for the farmer and agriculturist hardly equalled by any other country.

This unfulfilled demand applies to produce of almost every description. From the Avon Valley in the eastern districts to Albany in the south, Western Australia provides everything necessary for close and advanced settlement, for the farmer and grazier, for viticulture, horticulture, dairying, pig raising, stock fattening, potato growing, and for fruit growing. Large areas are open for all these. Linseed grows to very great perfection, and in this connection the time may not be distant when the cultivation of flax will enter largely into the avocations of the farmer. No better fruit can be produced in the world than in Western Australia, it is the transplanted home of the peach, nectarine, plum and all stone fruits, also of the apple, pear and quince, while the grape is both luxuriant and prolific in its growth. Immense specimens are general of all the gourd tribe, pumpkins, melons, marrow and their congeners, as also beetroot and mangel. Maize and the sorghum tribes are to be seen at all local shows, and visitors are astonished at these productions in Western Australia, which for years was understood to be a land of sand and drought. No more mistaken idea of a country could be formed, for while, in common with all territories embraced within such latitudes and longitudes, she has stretches of arid country subject to heat and drought, she has nevertheless enormous areas capable of supporting large populations, she has thousands of miles of country yet untouched by man that will gradually come under the influence of civilisation and cultivation.

INDUCEMENTS TO SETTLERS.

With all the advantages I have mentioned, with due appreciation of the responsibility resting upon me as one who has taken an active part in the politics of that country, and after having travelled much in the Old World and in other countries, I have no hesitation in saying that Western Australia to-day offers inducements for settlement that cannot be excelled, probably not equalled by any other country in the world. To the investor, in her gold and minerals; to the grower, grazier and general settler, on her lands; to the worker and artisan, in her public works; and to the manufacturer and tradesmen in the establishment of all those industries following in the wake of civilisation and advancement they are equally attractive.

Great public works have been undertaken by the Government, not only in the extension of the railway system to the most remote sections of our present goldfields, but in a water service that is to lift and pump 5,000,000 gallons of water daily something over 400 miles into the interior, at an elevation of over 1,300 feet, and which will probably cost something like £4,000,000 of money before it reaches the doors of the consumers; also in a harbour works, costing nearly a million of money, a harbour that will safely accommodate the largest steamers afloat, and in a thousand and one other public works to promote the advancement of the State. The Government, strengthened by an increasing revenue, have not been slow to anticipate the demands of settlement, and to promote the happiness and contentment of the people. Britishers going there will find, not only a sunny sky, but a country that will provide happy and contented homes if they will only help themselves by industry and perseverance. It must be remembered the ordinary conditions of life in Australia are as English as in England, varied only by the minor circumstances of climate and environment. The same common law of England applies in Australia, but there is a freedom and a breadth in the surroundings which inspire a more intense and active interest in one's neighbours than here, where the struggle for existence among the workers is more pronounced and acute. These are simple truths evidenced by the fact that the great majority—if not all—English people, after residing in Australia for a few years, would not exchange it to return to the land from whence they came. I must not, however, dwell too long on this aspect of the question for fear of exceeding the limits of this paper.

A COMPARISON WITH SOUTH AFRICA.

I have drawn attention to the gold output of the Rand in South Africa as against that from Western Australia, as showing in its gold resources that the latter was as rich if not richer than South Africa, and I desire to draw comparisons still further. South Africa, as a country for general settlements, is not equal to Australasia in the possibilities of agricultural production. I believe there is scarcely room to doubt this, and if it were not for her gold and diamond deposits, South Africa would not be so attractive a country in which to live as Australia; but allowing it to be so, allowing it to be a country possessing the possibilities of Australia, it would seem that South Africa has drawbacks from which the former is happily free, and must ever remain free. What is the history of Australia from first to last? It is English; the English settled Australia by gradual process, and English people alone have laid the foundations of a future great nation. Its record is one of ever-increasing progress and advancement; no wars, no bloodshed; under the protecting flag of Great Britain, the Australias have flourished. The public men, with the wisdom of their race, have built up their institutions on solid foundations; they have done this because no internal strife has ever existed as a disturbing element. But, with all these inestimable advantages, the richness of the country in gold, in minerals, and in the growth and production of practically every commodity under the sun, what do we find? That all the forethought and ability of their best men have been severely exercised in order to administer the affairs of the States successfully. Their borrowing powers have been used to a very large degree for the extension of railways, roads, harbours, and other public works, and for the general advancement and progress of each State; and, as I have said, in face of peace, in the face of a rich and highly productive country, it has taxed the best ability of the Australias to avert oppressive taxation. They have borrowed their millions from the Mother Country almost wholly for reproductive works, and they have to-day to face expansions and expenditures of Empire which, while they can be well met by the unbounded resources of the Dominion, will nevertheless call into play the greatest possible administrative talent to avoid future heavy imposts. But we are of one race, and one language, and the British investor has a heritage upon which he can rely. Now let us for one moment turn again to South Africa. What has been her history from the early days of settlement? For nearly 300 years there has been a series of wars and internal troubles. The Cape has changed nationalities more than once. The Dutch, a race possessing many of the characteristics of the British, who from time immemorial have crossed the path of the English, planted their flag in South Africa, and their thirst for a nationality has never been quenched, although it has brought them reverses and compelled treks from time to time to get and be "on their own." They are the same people now as ever, in face of reverses in the past, in face of the influence and wealth of the British, they became a power in South Africa—a dominant power—and with that power racial hatred increased. There can be no mistaking this. Race fusion has made few strides, and hemmed in though they have been on all sides by territories of other nationalities, they still made a bid for Empire and their own nationality in this last attempt to expel our race and drive us into the sea. We know what the struggle has been, we know what the struggle is, and we know what may be its immediate solution. We know them as a race, we respect them for their bravery, heroism, and loyalty—to themselves. We have 60,000 or 70,000 prisoners—Dutch speaking people—filled with all the traditions of the past, now crushed and silenced by that other race so well hated for centuries. South Africa will be English in administration like Australia; it may eventually develop the same free political institutions. The official and political language will doubtless be English, but will there be *rest?* Will not the leaven of the Dutch people be there ever alert, a simmering undercurrent of trouble and *unrest?* How many years will it take to fuse into one people? Hundreds of years have passed, and we find to-day the struggle between Dutch and English more fierce and deadly than ever. Will this bitter war change it? Will the Dutch embrace the English? Time heals all wounds, and enlightened administration will doubtless do much, but—from this aspect of the case—how does South Africa compare with Australasia as a home for English folk? Again, allowing there is nothing to apprehend from racial differences, and presuming South Africa to be, otherwise, as Australasia is. She has already a public debt contracted under the Transvaal and Orange Free State Governments, she will have an expensive administration to meet for some years, she will require large administrative expenditures in the development and progress of the country, and if these can be met by the natural resources of the territory, as in the case of Australia, it necessarily follows that those burdens will be greatly increased, following on the heels of a protracted and costly war.

Overshadowing this is the penalty of that war. The expenditure to Great Britain has been something over two hundred millions. Who bears this burden? Is the British taxpayer, with all his local taxation, to have it on his shoulders; is conquest to throttle him and bring the pinch to his door, while South Africa remains free of war charges? One can hardly imagine that, however long-suffering the British taxpayer may be, he will submit to this additional taxation, if those to whom relief is given alone benefit by the bloodshed and the millions without a call on their purses. This can hardly be so. The English taxpayer might well ask, under such circumstances: What is the use of the South African possessions? what is the meaning of the war? Does it merely mean the heritage of an unrestful territory over the sea? We have, however, heard that the interest on something like thirty millions will be expected from South Africa, a comparatively small, but still an immediate charge. But how can this be collected? What would be the position of the Australias if suddenly handicapped with a further debt of thirty millions, and nothing to see for it but a desolated country? Can South Africa pay this and still afford to the English investor the same guarantee as he finds in Australia?

With a war debt of two hundred millions hanging over South Africa, and an immediate charge of thirty millions, is not the security for all investments heavily handicapped? Will they not be handicapped to the full extent of the indebtedness of that country, whatever be their nature? Surely this must inevitably be so. Every industry, every undertaking in South Africa, must bear its share of the burden. It is said that the gold mines can easily pay this enormous debt, because the cost of gold production is small as against that of Australasia. There may be something in the application of low-priced black labour as against white labour. But we must not lose sight of the fact that black labour under British rule is a vastly different thing to black labour under the Boer rule, and black labour will, probably, not be slow to appreciate the difference and demand the same return as white labour as soon as the latter flows into the country. Again, if many thousands of European labourers go to South Africa and are given the franchise their voice will be heard for employment, and the cost of gold production will rise proportionately. I make these observations in no carping spirit against South Africa and her future whatever it may be, but with a view of showing the position of Australasia as more of the flesh and blood of the Empire, so that in the anticipated exodus of people from England to South Africa, investors and settlers may choose with eyes open. I have no desire to see the progress of Australasia checked by an unstable boom in South Africa. Australasia in common with the Mother-land has done her share toward vindicating the position of Britain in South Africa, but the call for population and further British investments in Western Australia and in the whole of Australasia is as great and as urgent to-day as ever. If the feeling of Empire is anything in Great Britain it should be to further advance those interests, as being the only part of Empire absolutely and solely English in language, people, and sentiment, and the actual embodiment and reproduction of Great Britain across the seas. I have drawn parallel lines between the two countries, I hope fairly and impartially, because great events are in the air affecting our Empire.

EMPIRE AND FUTURE AUSTRALIAN EXPANSION.

And now, if you will permit me, I will say a few words on Empire. I do so, feeling how very small my voice is in connection with such a subject, but having frequently mentioned it in this paper, I desire to say how easy it is to use words symbolising the gravest possible problems without fully realising their meaning. It is a simple matter to speak of Empire and to generalise on a theme subject to the widest possible interpretation. So long as we are not invested with any responsibilities in propounding measures for its solution, we can use what high flown terms we may, but the moment we attempt to think out a practicable scheme for the consolidation of the Empire comes the realisation not only of its gravity, but of its difficulties. We expect much from the projected conference of Premiers in London; it may have the effect of giving form to some ideal aspects of the question. Perhaps the air may be cleared, but all must, however, feel, that a question which so affects the great forces, powers and commerce of the world, must be one, slow in its evolution, reached step by step, as of one feeling the way on an unknown road. If we but cast our eyes over the map of the world and note the British possessions and British colonies it will convey at once to our minds something of the enormous scope of this question. Looking back to Australia let me for a moment quote some statistics of Sir Philip Fysh, published, I think, in 1899, at the inception of Australian Federation. He says:—

> "In 1787, when the United States made their beginning as an independent country, their population was 3,900,000, their revenue was less than £3,000,000, and trade inconsiderable. Britain in Cromwell's time had a population of 5,000,000, and a revenue of £2,000,000 per annum. Curiously enough, when the first draft of the Commonwealth Bill was framed, the population of Australasia was 3,900,000, but the resemblance to the United States ended there, for Australasia's total trade was £150,000,000—equal to that of the United Kingdom when the Queen (Victoria) came to the throne."

Australia of to-day has a population of 4,000,000, an annual revenue of £25,000,000, productive industries £130,000,000 per annum; a volume of trade of £130,000,000 per annum; shipping in and out of her ports measuring 10,000,000 tons annually; and she has accumulated £1,385,000,000 of material resources. Add two years of very material advancement, to the figures of Sir Philip Fysh in 1899, and that is what Australasia is to-day.

Well might the Heir Apparent to the throne exclaim on his return to his people, "Wake up! wake up!!" Meaning, "See Australia as I see it, as conviction forced itself to my mind, on realising the force of our people across the seas." The Commonwealth of Australia, newly-born as it were into national life, started that life under more auspicious conditions than those of the early life of the United States. But the United States has, since 1787, grown to 77,000,000 of people. Despite the absence of many of the advantages of the United States in the shape of internal waterways and geographical position, the future of Australasia is as full of great possibilities. The populations of Europe, increasing as they are enormously, must find an outlet for their local congestions; they must migrate. With the climate and productiveness of such a country as Australasia, capable of supporting them, willing to welcome them to her ample areas, she must become during the next fifty to one hundred years, if not as great as the United States, still a power that might yet form the sheet anchor of the British nation, for no other possession held by the nation can claim the same material and real advantages. The Australias, as I have said, are of one language and one people. Canada, if figuratively one people, has over two millions who are of French extraction, speaking the French language. The dual languages are the official languages of the Legislature. South Africa, as I have pointed out, has the Dutch as well as the English, while, in every other British possession, the British tongue is not the language of the country. You may be sure there is no point affecting the future Empire more vital than that of language, and if Australia of to-day, with her comparatively small population of four millions akin, and of the same tongue, can now supply a potent and reliable force to aid the Mother Country, what will the value of that force be in the near future? If the expansion of the Empire fosters and actually links together the ties which unite Australasia at this moment to the Mother Country, what will it be when she numbers fifty millions? Is it not well to think over such points, if they have the value which I place upon them, and let Great Britain focus some of her great and ever-resourceful energies in holding together Australasia.

As I have said, the process of Empire may and probably will be of slow evolution. A great and common danger from some unforeseen foreign combination may compel prompt action, and weld it into an unfusible whole. There are doubtless difficulties of policy, of prejudice and of interests of long standing to overcome and to reconcile. It would seem to me that when we are referred back to the traditions of England, to the policy and principles which have made the nation, we must not apply these principles to things as they exist to-day. In the past they were doubtless wise and far-reaching in the attainment of national prosperity, but the world has advanced to other stages higher and probably more potent in their issues. Factors are now present which were entirely absent one hundred years ago, and we have to face commerce, trade, and competition as resourceful as our own, stimulated not only by enterprise as active as our own, but impelled by the growing demand of their millions—to live. Preferential duties would seem one move in the right direction if the barriers of prejudice can be overcome. It demands a nation's people to do a nation's work. Men must rise above party and local interests in this duty to the nation, putting all other considerations aside in order to maintain the markets of the Empire within the Empire, and so secure to her people the best results for their labour. Events in the present age follow in rapid succession, leaving small chance of recall; if one false step is made many opportunities may be lost for ever. But, in the protection of the manufactures and trade of Great Britain, the interests and trade of Australasia must not be forgotten—preferential tariffs mean reciprocity—fair and equitable; sentiment and the blood tie are great connecting links between the Australias and the Mother Country, but international trade and commercial interests must further strengthen the chain, as any bonds, obligations, or contributions, not the free and spontaneous result of British and Australian sentiment, would not be effective. Great Britain with her colonies is not only a great manufacturing power but also a great producing power, equal to any other nation, and perchance when His Royal Highness the Prince of Wales exclaimed "Wake up!" some of these facts may have moved him. A preferential tariff may yet be found the potent factor in keeping the Empire together. But there are many others that must occur to all reflective men. I have Australians in my mind in this paper, and, being of them, may or may not reflect some of their sentiments. That the capabilities of expansion are enormous none can deny. In what way that expansion will occur, and the direction it will take, depends as much on the policy of Great Britain as on the statesmen of the Australian Commonwealth. If it is to be Greater Britain across the Sea, and its glorious traditions and sentiments are to be perpetuated, the conditions of Imperialism which makes Englishmen in England patriotic and loyal to the constitution and the throne, must also be in evidence in Australia in the creation of interests, whose vitality will depend upon the Imperial constitution. The aristocracy and domination of wealth alone is scarcely Imperialism, and does not mean Empire.

DISCUSSION.

The Chairman said the sincere thanks of the meeting were due to Mr. Venn for the able paper he had given, which was packed full of facts and contained much eloquence. He hoped the paper would help to divert some of the energies of the country to that vast field in Western Australia which had just been passed under review. It was not long since one thought of Western Australia as the country where Dampier, who was half buccaneer and half explorer, where Cook, Vancouver, Flinders, and Franklin discovered and added to England fresh country. But now our attention was drawn more to the marvellous rate of increase and growth in the capacity of the country. One was accustomed to marvellous growth in Australia at large, but the growth of Western Australia during the last decade had been almost more rapid and more marvellous. As Mr. Venn said, that growth had hitherto been based upon gold, the product of larger goldfields than could be found in any other part of the world, and which, in the last ten years, were only commenced to be worked. Mr. Venn had compared Western Australia with South Africa in the matter of its goldfields and its prosperity, and had shown that Western Australia had even more rapidly developed than the Rand. Another foundation for that prosperity was a most solid substratum of coal, which would be turned to good account when gold failed. Of course there were great political problems before Western Australia, but so there were before us all, in whatever part of the world we might reside. The political problems of Western Australia were obvious. There was the labour question and all its developments, which were sure to make themselves felt there. In the meantime there were difficulties which arose out of the recent great measure of Federation. Federation was welcomed for the sake of all Australia, but it brought its difficulties, which made themselves felt in the first session, when the relationship of the States to the Federation had to be considered, for it was very different from the mutually independent condition of the States in former times. But those difficulties were being faced, and would be satisfactorily solved; they were not such as need stagger or alarm any of the statesmen who controlled the destinies of Australia, or those here who watched with sympathy and every desire to help what was being done out there. As Mr. Venn had said, those political difficulties were as nothing to those of South Africa. He thought Mr. Venn drew an unduly dark picture of the difficulties in front of South Africa. He (the Chairman) believed that as a result of the war it would be found that many of the race problems and questions of feeling between the two peoples would be cleared out of the way, much more so than would have resulted from long years of disaffection. Looking at Australia one saw harmony, and he hoped that would continue in all the States under the Federation, and that there would be a growth in the cordial relations between the Australian States and the Mother Country. The political development of Australia had been almost as striking as the material advance of Western Australia. One saw commercial relations growing at such an enormous rate as to make possible the ideas which Mr. Venn had ventilated of a preferential treatment. Even though that did not seem to be quite in the immediate future, he thought it was not very far off. The strong feeling and cordiality based upon firm business relationships, had been very much developed by the events of the last war. The colonies knew they could rely upon the assistance of the Mother Country in case of need. But now from this war we had learnt the lesson, dear to the heart of every father, that it was not alone we who were able to help our sons, but the sons were willing and ready, and able to help the Mother Country in the time of its need.

Sir JULIAN SALOMONS, K.C., said that if Mr. Venn's paper were distributed by the Government of Western Australia, with a map attached, it would be a great advantage, and he knew but few of what were called romances which were so interesting as the matter in that paper. He did not question the wisdom of England, but admired her generosity, in giving to only 60,000 persons a territory as large as one-third of Europe. Though at the time he had the presumption to doubt whether it was justifiable, those few people had proved, by their wonderful energy, enterprise, and intelligent application of the forces around them, that it was justified. No doubt if we had been left to Imperial rule alone, the colony would have been far behind the position it now occupied. With regard to the figures in relation to time, he would presume to put much that was in the paper into one sentence. That sentence was: "At the time that America declared her independence she had not the population that Australasia has now." Although New Zealand had not yet joined the Federation, he had no doubt that under the influence of that very able and unselfish statesman, Mr. Seddon, it would not be long before it was brought about. He thought the paper would have been better if it had made no reference, either by way of admiration or of contrast to South Africa. He hoped one effect of the paper would be that some of the ladies present would send out their sisters and brothers to help to increase the small population of 200,000.

The CHAIRMAN said he was sure that those present would cordially join in rendering hearty thanks to Mr. Venn for his excellent paper.

Mr. VENN, in acknowledging the thanks, said he much appreciated the remarks of Mr. Parker Smith, who was a distinguished man in the politics of Great Britain, and Parliamentary Secretary to the Right Hon. Joseph Chamberlain. It was an honour to him (Mr. Venn) that Mr. Parker Smith had spared the time to be present at the reading of his paper. If any interest were aroused, or knowledge imparted by the paper, he should feel amply repaid.

Miscellaneous.

TRIALS OF ALCOHOL MOTORS.

While in this country alcohol has been attracting little attention as a fuel for internal combustion engines on account of the impossibility of this spirit competing with petrol, unless it is specially favoured by fiscal duties, it is nevertheless making a great deal of headway on the Continent. In Germany, the results have been so encouraging that the French Minister of Agriculture is now carrying out a series of trials in the hope of being able to demonstrate the efficiency and economy of alcohol, and thus popularise the use of a spirit which it is expected will do a great deal towards helping the agricultural industry out of its present state of depression. At a time when the values of agricultural produce of all kinds are depreciating, a considerable sum is being paid every year for foreign petroleum to meet the requirements of motor cars and internal combustion engines, which latter are becoming very popular among small power users on the Continent. The value of petroleum imported during the first three months of the present year was 18,724,000 francs, and the Minister thinks that most of this money ought to find its way into the pockets of French agriculturists. The trials began with a test of industrial vehicles from Beauvais to Paris, and included a three days' consumption test of touring carriages and a race of automobiles through the northern departments, by way of Chalons, St. Quentin, Arras, Boulogne, Abbeville, Dieppe, and Paris. Tests of fixed internal combustion engines using alcohol are also being held, and the trials will terminate with an exhibition, which is to be held at the end of the month in the Galerie des Machines. Twenty-one industrial vehicles assembled at Beauvais, where they were weighed without load, and the tanks, after being filled with alcohol, were sealed. To avoid any possibility of fraud, a cylindrical tank had to be used, and it could only communicate with the carburetter by a single pipe. Most of the vehicles were light vans and lorries weighing less than a ton without load, but the Société Nancéienne sent two big lorries as well as a huge tip waggon, with a tare of 4·11 tons, and carrying a load of 4·68 tons. This is one of two waggons that have been built to the requirements of a customer. It is propelled by a 12 horse-power Gobron-Brillié vertical motor, with two cylinders and four pistons, and the drive is taken through a chain from the primary shaft to the countershaft carrying the variable speed gear. It had been hoped that some of the vehicles would have employed pure alcohol, so as to allow of some comparison being made with the carburreted product, but the only one to use the pure spirit was the Peugeot van, which, however, was unable to finish the journey. Automobile users object to pure alcohol because it always contains a certain percentage of water, and this has a tendency to oxidise the valves, while the non-volatile denaturising ingredients also give a great deal of trouble—to such an extent that the valves have to be ground very frequently. Again, all the tests have shown that the consumption of pure alcohol is about a third more than petroleum spirit, and as it costs more in France than petrol there is obviously a great disadvantage in employing the pure spirit. These disadvantages are partly met, and may perhaps be entirely overcome, by the addition of benzine, which not only increases the efficiency of alcohol, but also reduces the cost, since benzine is a cheap by-product which can be produced in any desired quantity. Several users have been trying a mixture of 75 per cent. of alcohol and 25 per cent. of benzine, but this has been abandoned in favour of an equal mixture of both, and with the exception of the Peugeot all the vehicles in the industrial motor car trial employed half alcohol and half benzine. At present such a mixture sells at about the same price as petrol in the provinces, and is slightly cheaper in Paris, where the octroi duty on this spirit has been suppressed.

The distance from Beauvais to Paris is 58¾ miles, and the road for most of the way is very good, but with numerous heavy gradients. The 21 vehicles were sent off in the morning, each accompanied by an observer. Most of them got over the course without any difficulty, the only failure being the Peugeot van; but one of the Nancéienne lorries, finding its 3½-ton load too much, discharged 15 cwt. soon after leaving Beauvais. The highest speed was obtained by one of the light Darracq vehicles, which went over the course at the rate of 19 miles an hour, and the majority of the cars travelled at from 9 to 10 miles an hour, while the average of the Nancéienne tip waggon was 5 miles.

In making a comparison between alcohol and petrol, it may be said at once that the employment of the pure spirit is out of the question, except in the Colonies and in countries where the importation of petroleum is practically prohibited by heavy duties, or where the cane-sugar industry provides an abundant supply of alcohol as a cheap by-product. In Portuguese Africa, the sugar-cane planters are beginning to employ motor vehicles, and the Government of the Congo Free State is purchasing several automobiles in Belgium, which will shortly be put into service on roads specially laid out for the purpose, and distilleries are being erected for the production of alcohol required by these vehicles. But in Europe the whole question depends upon the economy of the spirit and the adoption of a fiscal system which will practically shut petrol out of the market. For years past the German Government has been carrying out a policy which aims at the exclusion of petrol; and by reducing the excise duties on alcohol, and allowing of its being denaturised with only a small percentage of methylene, the spirit is being sold in Germany for less than a shilling a gallon, while in France it cost the consumer nearly three times that amount. The Germans have naturally very strong inducements to use pure alcohol, and they have made a great deal of progress in the way of designing motors specially for alcohol, which are said to give excellent results, though they do not seem to have overcome the difficulty of oxidised valves. Moreover, as pure alcohol will not volatilise freely unless the engine is warm, the motor has invariably to be started with petrol. In France, the cost of using pure alcohol in an internal combustion engine is so high that the spirit can only be employed in its carburetted form, and previous trials have shown that in certain types of motors its efficiency is not greatly inferior to petrol, while the cost of carburetted alcohol is about the same as the petroleum product. It has long been observed that the best results are obtained in comparatively slow running motors, or in engines in which the explosions take place between the pistons, such as the Bardon and the Gobron-Brillié, and this is to be explained by the different conditions under which the gases are consumed in the cylinder. Petrol gives a strong impact on the piston, and the engine more nearly approaches a true explosion motor. With alcohol there is a longer expansion and it requires a longer stroke, as well as a larger cylinder volume. If a motor is designed specially for alcohol it must necessarily be heavier, and this fuel cannot be so suitable as petrol for motors which are required to develop high powers with the lightest weight in pleasure carriages. It is significant that at the Minister of Agriculture's trials there were only four vehicles with vertical motors—the Panhard at Levassor lorry, the small De Dion van, and the light Darracq vehicles. All the makers of comparatively low-speed horizontal engines, that is to say, running normally at between 750 and 1,000 revolutions, claim that their motors will work equally well with alcohol and petrol. As a means of comparing the two fuels we take four vehicles of the types that ran in the recent trials from Paris to Monte Carlo, and here we find that between Toulon and Fréjus, over roads which are extremely hilly, the Panhard omnibus, propelled by a vertical four-cylinder motor, consumed ·1087 litre of petrol per ton kilometre, while between Beauvais and Paris a motor of the same power consumed ·14 litre of carburetted alcohol. In the Gillet-Forest van, with a 7 horse-power single-cylinder horizontal motor, the consumption of petrol was ·0898 litre per kilometre ton and of alcohol ·1082 litre. The De Dietrich omnibus consumed ·0647 litre of petrol and ·0855 litre of alcohol, while the consumption in the lorry with the same type of two-cylinder horizontal motor was ·0751 litre of petrol and 0·0811 litre of alcohol. These results fully bear out all previous tests, and show that in the existing motors there is an appreciable increase in the consumption of alcohol; but whether this can be obviated by specially-designed engines is a question that has not received so much attention from French as from German engineers.

It is clear that if alcohol is to compete successfully with petrol, it must be sold at 15 to 20 per cent. below the price of petroleum spirit; and how this is to be done is a problem which the Minister of Agriculture will have to solve when he has demonstrated that alcohol is a suitable fuel for internal combustion engines. If the spirit is so cheap in Germany, it is due largely to the fact that it is distilled principally from potatoes, while in France it is hoped to obtain the alcohol from sugar beet. Even at the present price, however, the grower would not get much more than one-half of what it costs him to cultivate the beet, and therefore it will be necessary to grow some other produce, or else put some prohibitive duties on petrol. As one way of getting out of the difficulty, the Government has a project in hand for making the refining of petroleum a State monopoly, but nothing will be done to solve this intricate problem until after the termination of the trials.—*The Engineer.*

Correspondence:

THE INDUSTRIAL DEVELOPMENT OF INDIA.

Mr. Nikanth B. Waglé has received the following letter from Mr. Alexander Kinloch, Hon. Sec. of the Anglo-Russian Literary Society, Imperial Institute, respecting his paper:—

Dear Mr. Waglé,—The subject of your lecture appears to be of such great importance, and embraces such a wide field of reflection for the political economist, that it deserves much more deliberation than the mere utterances of a lectural discussion. My own knowledge of the subject is superficial, and I hesitate to pen the views expressed to you in our conversation, as you were good enough to request.

A life-long residence in Russia, and a study of its latest institutions, have caused me to watch with interest the measures which have been adopted there during the last decade by a paternal Government for the development of the industries and natural resources of the country.

I agree with Sir Lepel Griffin that there is a great resemblance between the economic conditions of India and Russia. Both countries are mainly agricultural, with two-thirds of their population peasantry; both are endowed with immense natural resources to a great extent dormant; in both countries the masses, and the agricultural community in particular, are almost entirely dependent on the aid of the governing bodies for their well-being and support. But I cannot agree with Sir Lepel that the attempt of the Russian Minister of Finance to foster the industrial at the expense of the agricultural development of Russia has been a success. His policy has certainly attracted a large influx of foreign capital into the country, and by bolstering it up with a strong protective tariff, he has vastly increased Russia's manufacturing capacity. The result is over production to a ruinous extent, which has within the last three years caused an industrial crisis. Moreover, the high prices followed by high wages have attracted the sinews of the agricultural classes into the towns, leaving in the villages women, children, and the infirm to till and harvest the land. The land is badly cultivated, the commune rates and taxes are in arrear, poverty and starvation are spreading in entire provinces, and the towns are being filled with an overplus population of disaffected artisans and factory hands, who are joining the revolutionary movements of the students and their allies and clamouring for higher wages in the midst of the crisis. M. de Witte has now discovered the mistake in his policy and turned *au rebours.* He now perceives that it is Russia's agricultural and not her industrial resources which require to be developed. The extreme ignorance and poverty of the peasant have hitherto prevented him from making adequate use of his resources.

The dairy products of Russia alone, if properly cultivated, could supply the wants of the whole of Europe. Thus it is not technical schools of art and science, &c., where they may learn to produce highly-finished manufactured articles, that the Russian people need, but proper knowledge of how to produce and to increase the production of their raw material. M. de Witte is apparently conscious of this. Delegates from the Imperial Agricultural Society have, under the auspices of the Russian Government, lately visited England for the purpose of acquainting themselves with the customs of the cattle and product trade existing here. Facilities are to be given financially, and the peasantry are to be instructed in methods of rearing, preparing, and packing the various dairy products, poultry, and game; and the breed of cattle is to be improved in order to meet the requirements of the British market. What Russia is now endeavouring to carry out with her dairy produce, could, I believe, be accomplished with India's corn-growing and valuable colonial products. The Mother Country England is so immeasurably ahead of her foster-child India where manufactures and industrial commerce are concerned, that it would require an enormous outlay of time and capital to enable India to enter into competition with the industrial markets of the world. The successful development of agriculture has, as a rule, been the forerunner of industrial progress in a country. Technical schools of art and science are excellent institutions where this dual development has already been obtained, and where sufficient capital has been accumulated to warrant the necessary outlay of such advanced education. The frequent re-occurrence of famines in India and Russia, as I have said before, are the outcome of the neglected state of the agricultural industry through the extreme poverty and destitution of small landowners. Both countries are unable, it seems to me, to recover from this wide-spread destitution without properly organised Government support. To quote your own remark as an appendage to my lecture the other day: "If England and Russia could both find means to bring about a better mutual political understanding, and come to a definite settlement of their frontier question in Asia, a considerable amount of the enormous strategical expenditure in India might be applied to ameliorate the destitute condition of the people, and remove this horrible scourge and national calamity."

I am, very truly yours,
ALEXANDER KINLOCH.

Obituary.

FRANCIS RAVENSCROFT. — Mr. Ravenscroft, founder of the Birkbeck Bank, died suddenly from a chill, on Sunday, 15th inst. He was born in 1828, and in 1851, at the age of 22, he founded the Birkbeck Building Society, the deposit side of which grew into the Birkbeck Bank. Mr. Ravenscroft was elected a member of the Society of Arts in 1871.

JOHN YEATS, LL.D., F.G.S. — Dr. Yeats, a member of the Society of Arts of nearly fifty years' standing, died at Chepstow, on the 14th inst., in his 80th year. He was elected in 1854, and filled the office of Examiner in Commercial Geography for the Society from 1875 to 1888. He was the author of several works on commercial subjects, such as—1. "Natural History of Commerce;" 2. "Technical History of Commerce;" 3. Growth and Vicissitudes of Commerce;" and 4. "Recent and Existing Commerce," a third edition of each of which books was published in 1887. Other works were—"The Golden Gates of Trade with our Home Industries," 1890, and "Map Studies of the Mercantile World," 1890. He also read several papers before the Society, the first of which was a lecture in connection with the Educational Exhibition (1854) on Public Instruction in Holland and Belgium, and the last in 1878 on "Higher Commercial Education," for which he received the Society's silver medal.

RAJA SAIYID MUHAMMAD BAKIR ALI KHAN, C.I.E.—An extensive genealogical account of the late Raja Saiyid Muhammad Bakir Ali Khan, C.I.E., of Kotaha and Pandrawal, Member of the Society of Arts, who died on the 20th January last, appeared in the *Oudh Ukhbar* (an Urdu journal) of the 5th April. The biographer states that the late Raja's ancestors obtained a jagir of Pundri and other villages from the Emperor Bahlol Lodi (1452-1489 A.D.). During the reign of Aurangzeb three brothers were in joint possession of this property, viz., Saiyid Muhammad Kasim Ali Khan, Saiyid Ahmad Husain, and Saiyid Kamaluddin Husain. The eldest, Kasim Ali Khan, received the Zamindari of Kotaha from the Emperor Farrukhsiyar, as a reward for distinguished military services, and Muhammad Shah Ghazi subsequently added to this an estate which had been left by Dipchand without an heir. Kasim Ali Khan also acquired 71 other villages by purchase.

A considerable portion of this property was taken possession of by the Gurkhas during the time of Mir Muhammad Jafar Ali Khan, grandson of Kasim Ali Khan, but was recovered in 1816, with the aid of the British forces under Sir Daniel Ochterlony. Jafar Ali Khan was succeeded by his son Mir Muhammad Akbar Ali Khan, at whose death his nephew, the late Raja, son of Kasim Ali Khan II., succeeded as ruler of Kotaha and Morni.

Saiyid Muhammad Bakir Ali Khan was well versed in Persian and Arabic, a skilled architect, and possessed of a remarkable memory. His kindly disposition, liberality, and just administration rendered him extremely popular amongst his people, by whom he was much beloved. He was also noted for his strong religious principles, his support of Muhammadan festivals and institutions, and his endeavours to promote the spread of education. He heartily co-operated with Sir Saiyid Ahmad Khan in the foundation of the Muhammadan Anglo-Oriental College at Aligarh, and was one of the chief contributors, and an ardent supporter of that institution.

A special memorial meeting of the trustees of the College was held on the 22nd January, the proceedings of which are fully reported in this issue of the *Oudh Ukhbar*, which also gives an account of a meeting of the leading men of Pundri, and 17 chronograms in verse, by various contributors, expressing the year of the Raja's death according to the Christian and Hijra eras.

Journal of the Society of Arts,

No. 2,588. Vol. L.

FRIDAY, JUNE 27, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-eighth Annual Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 9th July, at 4 p.m.

(By order of the Council),
Henry Trueman Wood,
Secretary.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill Prize of £50 and a Silver Medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges no paper deserving the full award is sent in.

LOAN EXHIBITION OF ENGRAVING AND ETCHING.

The following are the regulations for the Exhibition of Engraving and Etching, which the Board of Education have decided, at the suggestion of the Council of the Society of Arts, to hold, during the early part of next year, in the Victoria and Albert Museum, South Kensington:—

1. The Exhibition will consist of examples, both old and modern, of copper and steel engraving—line, mezzotint, and stipple (plain and coloured); aquatint; and etching.
2. The Exhibition will be confined to works specially invited.
3. All exhibits contributed unframed will be framed by the authorities.
4. The Exhibition will be opened at the early part of the year 1903, and will remain open about three months. All works should be sent in not later than 15th November, 1902.
5. Every care will be taken of all works sent for exhibition, but the authorities of the Museum will not be responsible for any loss or damage.
6. All works to be sent to the Storekeeper, Board of Education, South Kensington, S.W., and all communications to be addressed to the Secretary, Exhibition of Engraving and Etching, Board of Education, South Kensington, S.W.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, May 27; Sir George Birdwood, K.C.I.E., C.S.I., Vice-President of the Society, in the chair.

The Chairman said Miss May Morris was well known to her audience of that evening as the author of an admirable manual on "Decorative Needlework;" and by the learned and interesting paper delivered by her before the Applied Art Section of the Society of Arts just seven years ago [Feb. 26: see *Journal*, March 8, 1895], on "Mediæval Embroidery,"—from the 13th to the 15th centuries, inclusive. She had most graciously prepared her present paper on "Pageantry and the Masque" at a moment's notice, to fill the place of another paper unavoidably postponed. Miss May Morris had, with felicitous sympathy, selected a subject closely associated with a rarely recurring and significant national and imperial rite—the sacring of a King—

the preparations for the pomp and circumstance of which preoccupied the attention of patriotic and loyal Britons during the current months; and this would add to the other attractions of her paper something of the realism of contemporary actuality,—much as the distracted and scared present would suffer from comparison with the self-possessed and serene past of pageantry and the masque.

The paper read was—

PAGEANTRY AND THE MASQUE.

By Miss May Morris.

[ABSTRACT.]

After observing that it would take the scholar's habit of mind and the scholar's industry to do justice to the subject on its seriously historical side, and disclaiming any such depth of research for her paper, Miss Morris compared the elaborate Court masques with the earlier popular festivities and gild plays.

"For us the flourishing time of pageantry and stately shows is in the days of Elizabeth, of the first James and the first Charles. Ben Jonson wrote with a subtle pen, and his stage directions and notes of colour and symbolism are so richly imaginative that, even failing any contemporary matter relating to the Court masques of his day, we should still be enchanted by the beauty of these costly revels, these Twelfth-Night wakes and birthday rejoicings wherewith lords and ladies complimented each other incesssantly. But the Court atmosphere can easily become oppressive, and it is scarcely with regret that we turn to the religious play and popular representations whence the actual pageant-scene arises. At the outset, having it in my mind to talk to you about the pageantry of kings and queens of a certain epoch, I soon found that the limit had to be overstepped, and found also that the charm which surrounded these entertainments is really enhanced by some knowledge of their beginnings, and the idea of their more or less remote relationship with the early passion plays, with the gild-plays and gild-pageantry of the towns and corporations."

With respect to the derivation of "pageant," Professor Skeat has a long article on this word, in which he traces its history by the help of Way, Wedgwood, and other etymologists. The primary signification of *pageant* appears to have been a stage or scaffold, which was called *pagina*, a stage or platform. Another word for the old stage was *pegma;* this is the corresponding and cognate Greek name from Greek πῆγμα (stem, πηγματ-), a platform, stage, derived from the base of Greek πήγνυμι, I fix, cognate with Latin *pangere*.

Pageant, or pegma, then, a scaffold or stage where the drama or one scene of a drama, or the device, is shewn; the thing itself, some set piece of mimicry, was one of the essential features of triumphal processions, and royal entries and the like; it also was the part or scene into which the mystery-plays of the Middle Ages were divided. These plays, religious or edifying, were performed as well under the auspices of the Church as by the different craft-gilds, becoming finally a most important feature in the festivities in all English cities of any account.

Miss Morris here read Daniel Rogers' well-known description of the Chester Whitsun plays, and the order in which the pageant-waggons went through the streets of the town, stopping to play at various set points.

She also read some of the entries of the pageant accounts of the Smiths' Company at Coventry, among them the following:—

	s.	d.
Paid to Herod and Caiphas......	iii	iiij
Pilate's wife	ij	
To the Beadle		iiij
To the Devil and Judas		viij

and among other items—

To Fauston for cockcrowing		iiij
To Fauston for hanging Judas ..		iiij
Item, for making the Devil's head		xviij
Item, for mending hell mouth....		iij

Hell mouth was a very popular feature, and received considerable attention, the items in the accounts concerning it running more often into shillings rather than pence.

Turning next to the subject of street-pageantry, Miss Morris, by way of comparison, gave a description of a 19th century Lord Mayor's Show, and then one of a City festival, on the occasion of Richard II., the boy-King, entering London. This was taken from Walsingham's "Chronicle."

"The citizens assembled at the Tower where the King then was. They all rode towards Westminster by the most frequented roads. The counts and barons of the realm were all dressed in robes like the King's, white in colour, in token of his youthful innocence. The City was hung with cloth of gold and silver and silken stuff, and adorned in every conceivable way to do honour to the King, and the conduits ran wine for three hours. At the other end of the Cheap was erected a castle with four towers, on two sides of which ran wine abundantly. In the towers were placed four beautiful virgins in stature and age like to the King, apparelled all in white. These damsels, on the King's approach, blew in his face leaves of gold, and threw on him and his horse counterfeit golden florins."

Extracts were then read from Fabyan's Chronicles of the long and elaborate progress of Henry VI. through London City, and presenting it as a type of royal processions of the Middle Ages, with its groups and pageants and verses and gifts of grace, the lecturer observed that the tradition of it was carried on under the changed conditions of Elizabethan and Jacobean times. While it itself is losing spontaneity, as all traditional shows must do at last, the Court pageant has arisen, taking an important place in the history of art, and assimilating some of the features of the earlier popular rejoicing.

The best possible notion of the full-blown Court masque can be had from Campion's in 1606, where the stage, arrangement of the hall, the dancing-floor, the placing of the musicians and singers and so forth are all fully described. In its complete form the performance consisted of masque and anti-masque, the latter an introduction or foil to the brilliance of the principal piece. Though there is a transformation in Campion's masque —for instance, the golden trees which vanish and disclose their dryads, there is no anti-masque, whereby the performance gains greatly, by the way. Those who have not read Ben Jonson's "Masque of Queens," have, in the grotesque portion of it, to imagine the boredom of the witches in Macbeth a hundred fold multiplied! The movement was sometimes in one set scene, but more often the scene changes. Every masquer is accompanied by his or her torchbearer, who precedes the entrance and exit of the personage. The dresses are of extreme richness, and the characters usually carry some device of fanciful contrivance. In the Queen's "Masque of Darkness," among the symbols are some reminding one forcibly of the early Italian figured silks with their Eastern quality—a golden tree laden with fruit, a salamander, a cloud full of rain, an urn sphered with wine, a pair of naked feet in a river, &c.

An account of Ben Jonson's "Masque of Darkness" was then read, including a description of its performance by the Queen and her ladies, from an eye-witness with a lively pen. Ben Jonson's own directions for this masque are beautiful. It was an important occasion, too, because he definitely notes down that he had the assistance of Master Inigo Jones, a courtesy which was rare, as they were soon to quarrel.

Extracts from a list of the expenses of one of these revels were then given: it was "Tethy's Festival, or the Queen's Wake," on the occasion of Henry being created Prince of Wales. Some of the items are picked out for their delightful sumptuosity of colour:—

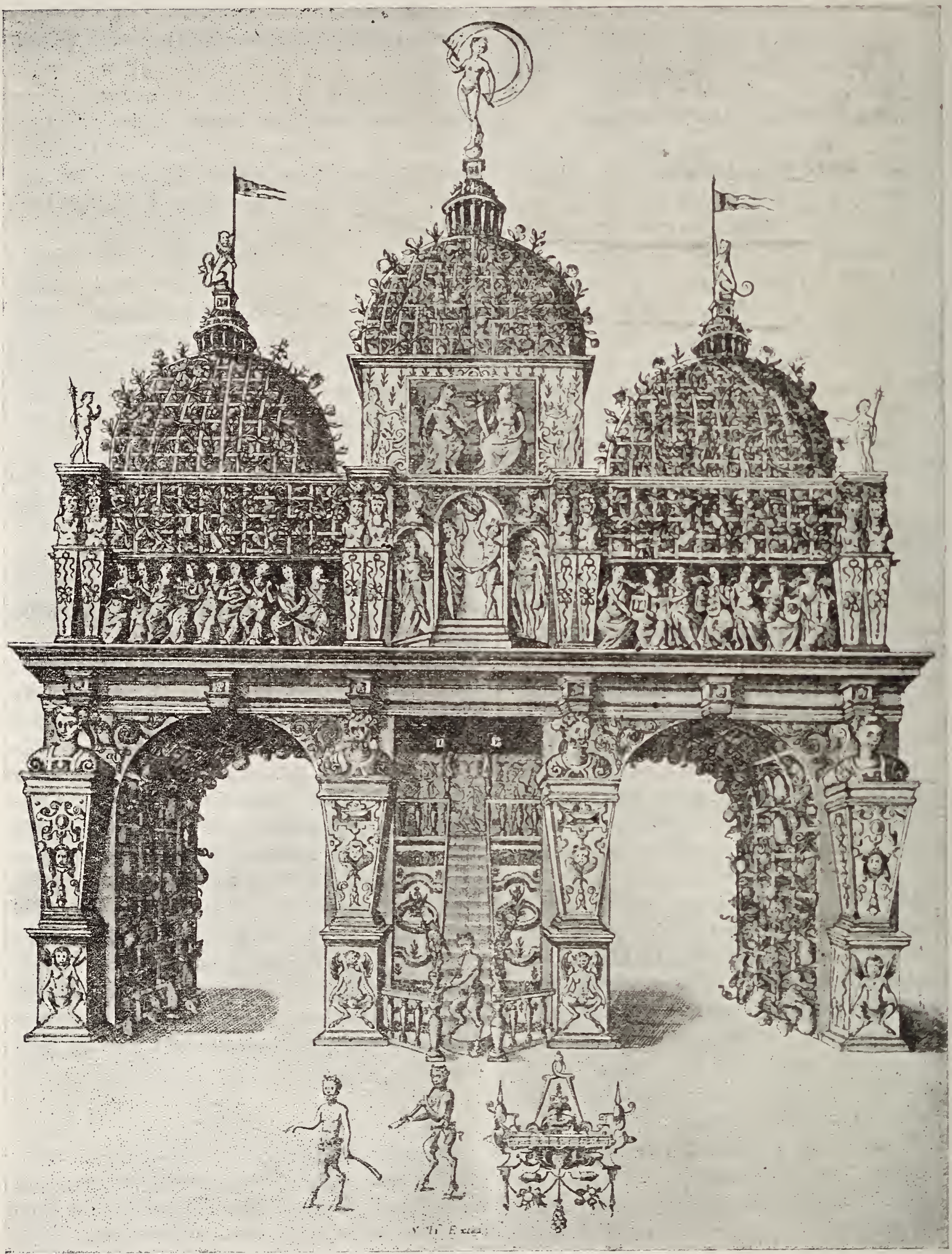
"Imprimis for embroidering the skirt of cloth of silver, the petticoat of watchet taffeta, and bodice and sleeves of sea-green taffeta, £27. Item for embroidering seven yards of cobwebb lace with vains of silver and sea green, and silver ●ose and carnation silk, £7. Item for embrodering a pair of shoes, of sea-green satin, very rich, £3."

Among the expenses of the Christmas Masque of the same year, are the following items of professional fees paid:—

"Rewards to the persons employed in the Masque:—To Mr. Benjamin Jonson, for his invention, £40. To Mr. Inigo Jones, for his pains and invention, £40. To Mr. Alphonse for making the songs, £20. To Mr. Jonson, for setting the songs to the lutes, £5. To Mr. Confess, for teaching all the dances, £50, &c."

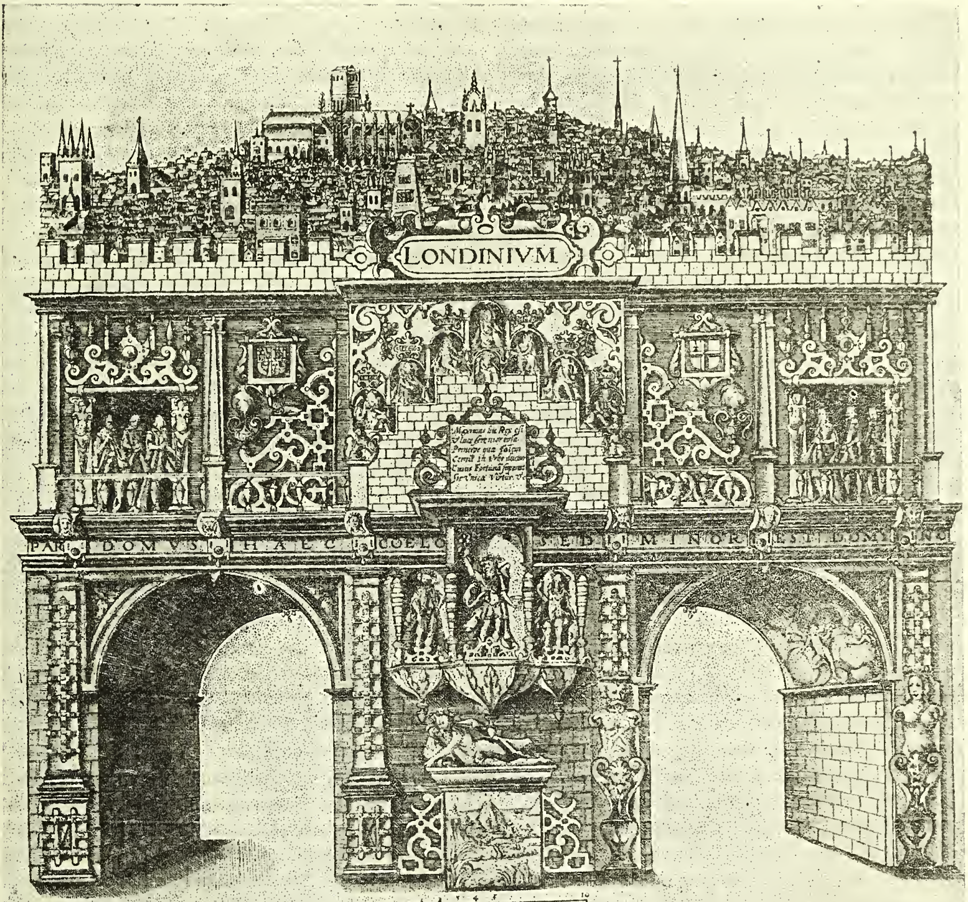
Before closing her paper, Miss Morris made mention of a visit to the City by William IV., which was prepared for, but did not come off, and dwelt with evident pleasure on the sympathetic spirit shown by those who designed the decoration of the "outline and architectural proportions of the Gothic edifice," *i.e.*, the Guildhall; the result was a somewhat unconvincing medley of gilt rosettes, silk tassels, and festoons of gas, "amidst which stood forth the white marble monuments of Chatham, Pitt, Beckford, and Nelson."

The paper was illustrated by a fine series of slides, the most noteworthy of which were a selection from the Triumph of Maximilian. In connection with these, quotations were made from the writings of the Emperor's secretary, who gave a full description of what elements should compose the triumph. The whole work consists of the *Triumphal Procession*, *i.e*, 137 plates, largely by Burkmeyer, and some under the influence of Albrecht Dürer; *the Arch*, partly by Albrecht Dürer, and the *Triumphal Car* wholly by him. The earliest of the blocks has the date 1516. Among the slides shown were the



The Device called Hortus Euporiæ, Garden of Plenty, near the little Conduit in Cheape.
(From Stephen Harrison's Arches of Triumph, erected in honor of James I., 15 March, 1603.)

"Golden Mummers," two pageant-wagons illustrating the Emperor's victorious wars, one of a long series of "Fiefs of the Empire;" knights in their tilting armour, &c. All of Hogenberg's prints were given illustrating the entry of Charles V. and Clement VII. into Bologna in 1530. Another series was shown as not only interesting in itself, but as a pictorial representation of all those fanciful festivities Henry VIII. so loved and Cavendish described so charmingly, *i.e.* the feasts at Westminster in 1510, published in *Vetusta Monumenta*, from which the slides were made by the kind permission of the Society of Antiquaries. Some of Harrison's arches were also shown—the first, with its delightful crowning picture of London clustered about the Gothic St. Paul's. The Arches were erected at the expense of the City Companies and the Foreign Merchants, for the procession of James I. through "his honourable Citv and Chamber of London" (1603). The first *Pegme*, and the last, were devised by Ben Jonson. The fifth


LONDINIVM
PAR DOMVS HAEC COELO SED MINOR EST DOMINO

THE DEVICE CALLED LONDINIUM IN FENCHURCH STREET.

Pegme, "The Garden of Plenty," was an arbour of clustered fruits and boughs "which seemed to grow close to the little conduit in Chepe, which served as a fountain to water the fruits of this garden."

DISCUSSION.

Mr. **Bernard Shaw** said he was very much intimidated and crushed by the result of his own efforts to try to keep our public bodies in a somewhat appreciative condition of pageantry. Therefore, he hardly knew how he could give his experience without committing himself in a very painful manner. However, he would try to give the meeting an idea of how he had tried to get a public body, brought up with the influences of the nineteenth century, to make a success in artistic decoration. First, however, he would like to interject the wish that Miss Morris could be persuaded to give her paper to everybody who came into London at this particular time, for it would be very instructive to watch the result upon the various minds. He was sure the result would be an astonishment to many hardly anticipated by them. He could not help being struck with the description which had been referred to of the time of William IV., when the lighting arrangement of the beautiful Gothic hall had been mentioned as being with "gas." He felt sure the present audience recognised that this was not quite following the lines of high art, but he rather believed that it would fall in with the views of the majority of the councils of the various districts as the "proper sort of decoration." To show the taste and understanding of pageantry at the present time, he instanced a point connected with his own particular district. The local body was presented, or rather offered, a very handsome mace. He went to one of the principal individuals concerned and suggested that a mace was a thing into which one would be expected to put fine silversmiths' work and obtain a good design. In the end the man he conferred with said he thought the idea was right, that the artist should be a first rate one, and he would be pleased to give £5 to that artist. He (the speaker) suggested that there should be a consultation with the Central School of Arts, and that an offer should be made of a sum of money sufficient to get the design properly accomplished for the mace. The result was that the matter went to the students, who spent a great deal of money in materials for a design. In the end a letter was received from the Town Clerk of the district to which the mace was to go (much to the surprise of the students) to the effect that the mace, which had been the subject of voluminous correspondence, had been finished by the manufacturers, but that they might themselves have the design, for which a place had been left blank, fixed on. How, under the circumstances, could he (the speaker) who had taken such great interest in the subject, be expected to speak with any sort of enthusiasm, or expect to get any good out of public bodies like that? So long as one considered the thing merely in the abstract one would have plenty of enthusiasm, but when one had to deal with the art side the best thing would be to try, in a perfectly friendly manner, to prevent public bodies from dealing with it all. With reference to the forthcoming Coronation pageantry he had no great hopes. Nothing would be well done in the way of artistic design. Just as Miss Morris had said the one good thing in the Lord Mayor's show was the fire brigade, probably in the Coronation processions the chief features would be the bands and the machine guns, those things which were produced for some sort of use. He had really come to the conclusion that the one thing to do was to implore the people who had nothing to do with art to work and take their chance of any beauty that might come along. In conclusion, he only wished to refer to the interesting picture shown that evening of an Elizabethan stage. As a practical dramatist he much wished that he could get a stage of the description shown instead of the stage of the present day—a stage where one saw the whole thing thrown back and only seen from one point of view. The paper had given him great pleasure, and the lantern display had been simply delightful.

Mr. **W. Martin**, LL.D., said Miss Morris had alluded somewhat explicitly to the events which would be pourtrayed in London during the next month. He would have liked, however, to have heard her ideas as to the form of decoration, or the way in which the pageantry ought to be placed before the eyes of the people during the Coronation festivities. He felt a certain amount of horror at the idea of the decorations which would be in the streets. At present when one looked around London one saw the whole place filled with objects resembling packing-cases. He supposed the next thing to happen would be to cover those packing-cases with a sort of Turkey red, after the fashion of the old ottomans which ladies used. Then there would be the spectacle of pieces of carpet hung outside the windows. This certainly did not satisfy the aspirations of some people of the present day. He would much like to have had from Miss Morris some description of a form of decoration which would satisfy them at the present time. He thought, however, the thanks of the meeting were due to the lady for her admirable paper. In conclusion, Mr. Martin said that if we had a good knowledge of what occurred in the past we should know how to make improvements in the future.

Mr. **H. B. Wheatley** said he was sure all present were grateful to Miss Morris for the vivid picture she had presented of the pageantry and masque of former ages, and also for the beautiful slides she had shown. One of the points which must be kept in mind was that although doubtless the ancient pageants were excellent we received our impressions of them from the descriptions written by the men who projected those pageants rather than from descriptions of eye witnesses. So possibly fog and rain in London sometimes interfered with the result, particularly at the dull time of the Lord Mayor's Show. One reason why pageants could not be so good now as formerly was due to the number of uninteresting carriages. They had seen from the lantern slides that in former times the processions were made up almost entirely of horsemen.

The CHAIRMAN said they were under the deepest obligation to Miss May Morris for her paper. She had treated her subject with familiar knowledge, sound discrimination, and perfect lucidity, and with a pertinence of literary reference and allusion, and a play of sprightly fancy altogether delightful. The lantern slides had most happily illustrated her text; and all present would add their tribute to the charm of manner with which the paper had been delivered. But before proceeding to move the vote of thanks doubly due to Miss May Morris, he desired to add his own contribution to the discussion, but relatively only to the question, suggested both by Miss May Morris and Mr. Bernard Shaw, of the cause, or causes, of the decay during the past two hundred years of the pageantry of the streets and highways, and of our public life generally, in this country. This was one of those great matters, too high for him, in which, nevertheless, he was always exercising himself; and the only conclusion on it he could advance was that the decay was attributable to the gradual failure of faith throughout Protestant countries in the sacramentality of universal nature; faith in which would seem to be the originating, continuing, and ever elevating force of the whole art of life—including its every artistic and picturesque presentation—as at once the symbol and assay of a life beyond life. At least among the historical nations who still followed in the faith of their fathers, the pageantry of popular life remained as spontaneous, real, and convincing as it was in once Catholic England. In India the people, and emphatically the Hindus, continued to live, and move, and have their daily being, as from antiquity, in the frankest, freest, and most familiar, and the most joyous communion with their gods; the greater gods of earth and sea and sky, and the lesser gods—imaged of roughly hewn stocks and stones—of their streets and roadsides, and the Lares and Penates of the recesses of their homes,—figured by strange forms of rudely cut and beaten brass and copper: and certainly the pageantry of their common life,—in which nothing was common or unclean because all was divine,—shapes, and colours, and fills the complete diurnal and annual round of the dædal globe whereon they tread. Every morning at sunrise the women are to be seen in their long flowing robes of white, or pink, scarlet, black, blue, yellow, or green, perambulating in archaic Aryan worship the four horned altar on which the pot of "Holy Basil" is placed in front of every Hindu house, invoking the blessing of the Almighty on the House Father and Mother, and their Sacred Family. The fields, and villages, and towns, are periodically perambulated in the same way; and thus the whole world of India is, at times, to be seen out in the dewy sunshine of the dawn walking with God.[*] Again every evening as the fiery orb of the sun sets silently below the unclouded horizon it is solemnly saluted: when, in the sudden night which follows, the temples are all brilliantly lighted up and visited in turn by the thronging crowd.[†] Then there are the great Festivals of the Gods for every month, and almost every week, of the year. The festival of the Winter Solstice is held in Bombay [early in January], in honour of the ancient Vedic Gods, Indra [the Rain], Varuna [the Waters], Agni [Fire cf: "ignis"], and Surya [the Sun]. The moment the sun enters the sign of Aquarius, all the people go down into the sea, and rub their bodies over with sesamum seed, the favourite seed of the sun, for the pure, bright light its oil gives; whence the phrase, "Open Sesame." The rest of the day is spent in out of door and indoor rejoicings; and wherever friends meet they offer each other comfits of Sesamum seed, saying, "Take, eat these comfits of Sesamum seed, and think kindly of me throughout the coming year." At the celebration of the Hindu New Year's Day [21 March], the standard of Indra is set up in front of every [Hindu] house in Bombay. It must be set up before every house, for, on this day, it is raised in honour of Indra on the inestimable height of highest heaven; and the will of the gods is to be done on earth even as in heaven. So on this day the standard of Indra waves in every wind under the firmament, over all India; and at night, in Southern India, his bonfires blaze on every hill. But the Holi festival [early in March], held in honour of Krishna, is the great saturnalia of the Spring Equinox in India, and the greatest popular pageant of Western India. In the surging tide of the processions which traverse every street of Bombay the whole life of

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[*] This perambulation [*pra-dakshina*, "advancing—with face to the sun,—right-hand-wise,"—compare Deisul] in the direction of the sun's course from East by South, and West, and North, round to East again, the most ancient rite of Aryan sun worship, survives to this day in the service of the sacring of our English Sovereigns. In annointing the Sovereign, the Cruciate or Western order of enumerating the four quarters of the heavens is observed, *i.e.*, the forehead and breast, and then the left and right arm, are in succession touched with the annointing balm; but in the previous presentation of the Sovereign to the people, the Archbishop, in reciting the terms of "Recognition," observes the Circular or Eastern order of the four quarters of the heavens, addressing the assembled company successively toward the East, South, West, and North. It is to be observed also that the "Colobium Sindonis" with which the Sovereign is after unction invested, originally meant a "a tunic of Indian [Sindian] stuff," *i.e.* cotton—not linen, as now,

[†] These simple rites recall the "Hymnus ad Gallicantum" and the "Hymnus ad Incensum Lucernæ" of the primitive Christian families. [Prudentius].

Krishna is enacted, and particularly his sports with the shepherdesses [*gopis*], the mingled crowd of devotees as they tumultuously advance singing hymeneal songs, and throwing red powder [*gulal*], and flowers, and sweetmeats, and squirting coloured and scented water at each other, and at the images of the god borne aloft among them. At the close of the festival, bonfires are lighted, into which the Holi cake is thrown as a burnt offering. Much fun also goes on in making people "April,—or rather March,—Fools." The Summer Solstice is celebrated all over India [end of June], but in Bombay the rejoicings are of rather a domestic than public character, on account of the heavy rains at the setting in of the South-West Monsoon. The annual procession [about the middle of September] of Ganapati or Gan-esa [literally "Lord of the Hosts (gangs of heaven) the God of Wisdom"], presents in Bombay and Poona a scene of unbounded mirthfulness. Every house contributes an image of the god to the procession, in which every member of every family joins. The images of the gods are each carried in a palanguin, profusely hung with the choicest flowers of the season, the god himself also being crowned with roses. With loud shoutings and laughter the gigantic procession makes for the sea, or for some tank, where the images are thrown into the water, in which the god is supposed to pass the night; and that night no one may look the moon in the face. The Dasara [last week of October] is the great Indian festival of the Autumnal Equinox. In Bengal it is held in honour of the dread goddess Kali or Durga the wife of Siva, the God of Destruction; and the great nocturnal procession of the goddess, with its interminable blaze of torches and coloured [Bengal] lights, blue, red, and green, and incessant detonation and deflagration of fireworks, and its wildly whirling crowd of leaping and yelling men, holding up over their heads the mystic vase containing the conjoined symbols—crossed triangles, and lotus "Knop and flower,"—of Kali and Siva, and of dancing and singing women—waltzing round and round and in and out the uproarious on rushing turmoil, and singing as they waltz in robes of the brightest motley,—the procession from end to end lit up luridly against the blackness of darkness of the night, in which the high tottering images of the goddess are partially lost;—all this presents a seething spectacle of frenzied religious enthusiasm, indescribable in its impression of weird and phantasmal picturesqueness. In Bombay, the solemnity is characteristically kept as a great military pageant, in honour of the tremendous war, sung of in the "Mahabarata," between the heroic Pandavas and their cousins, the equally heroic Kauravas. From every rural village and town the higher and lower hereditary officials, and the whole body of the cultivators, issue forth in great gala, and perambulate the bounds of the township, or village, and worship the trees defining them, particularly trees of such rich and showy efflorescence as the Butea frndosa [*palas*, whence Plassey], Cassia fistula [*bawa*], Prosopis spicigera [*shami*], and Bauhinia racemosa [*apta*]. In the "native states," the Hindu princes and chiefs, ride forth on their painted horses,* in the full gorgeous panoply of mediæval war,—like to

> "The great Emetrius, the King of Inde,"—

with flags flying, and blare of trumpets, crash of shawms, the piercing notes of high shrilling pipes, and the measured bangs of a well belaboured big drum; and, with their whole conrt, arrayed in the richest apparel of state,—robes, turbans, and fluttering scarfs of yellow, edged green, and every tinct of red edged yellow, and white edged red, and black, white, and blue, dull orange [*bhagwa*], the caparisons of the same colours as these edgings, and overlaid with gold plates and studs, richly embossed, and resplendent with talismanic gems;—and all garlanded with flowers, as are also the musical instruments, and the tall spears, and the flags. And so the gay calvalcade rides on and on into the green wild, to some full blooming Butea,† or Cassia, or Prosopis, or Bauhinia, that has beforehand been marked out as its cynosure and goal; and perambulating it 7 times, or 9, or 12, 19, 21, 84, or 108 times, gathers its golden flowers in arms-full, calling them "gold" [*sona*], and offering them on the return journey, as "gold" to the idols of the wayside village temples. Going and returning, wherever these gallant companies ride, the good Lord Sivaji, in their vision, rides on before,—just as St. George once rode before our English chivalry,—Sivaji, the partizan leader of the Mahratta race against the suzerain Mogol, and the idolised personification of their impassioned patriotism and romantic valour. Such is the Dasera of Western India, and in all the instinctive, spontaneous ritualism of Hindu life this solennial pageant of the Mahratta Princes is

> "— the master dream, of a life of dream,
> And the faith of a flower's beauty."

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* They are stained on their manes, and tails, and legs below the knee,—the milk-white horses red, the black white or yellow, the red green, and so on.

† All these trees flower in the spring, but one or other of them, if it be only a solitary example, is always to be found conspicuously in flower also in the autumn. While revising the proof of these remarks I note in the *Pall Mall Gazette* of this afternoon [17th June] that the town folk of the Royal Burgh of Linlithgow are this very day summoned to the ceremony of marking the bounds of the town in the following traditionary terms:—"Oyez! Oyez! Oyez! The burgesses, *craftsmen*, and whole inhabitants of the Royal Burgh of Linlithgow are hereby warned and summoned to attend my Lord Provost, Bailies, and Council *at the ringing of the bells* on Tuesday, the 17th day of June curt., for the purpose of riding the town's marches and liberties according to the use and custom of this ancient and honourable burgh royal, and that *in their best carriage and equipage*, *apparel*, *and array*, and also to attend all diets of Court held and appointed upon that day by my Lord Provost and Bailies, and that under the penalty of £100 Scots each. God Save the King and my Lord Provost." The italics are mine.—Geo. B.

The Divali, or great Feast of "Lanterns" [about second week in November] held in Bengal in honour of Kali in her more beneficent aspect, is in Bombay again characteristically celebrated in honour of the joyous Lakshmi, the Goddess of Good Luck, or Good Fortune, the wife of the Lord Preserver Vishnu. Every house in the town and island is traced out with "rows of lamps" of cocoanut oil, which gives a soft pure flame of the most perfect and far-reaching illumination, irradiating the whole town of Bombay, and the whole length of the Island of Bombay from Mahim to Colaba, in an illimitable light of the most ethereal splendour, reflected far out into the Erythræan Sea. The eyes that once gaze on its glory remain under its enchantment for ever. The great Mahometan religious solemnity of the "most holy" Muharam, held in perpetual memorial of the massacre of the sons of Ali, Sir George Birdwood said, he had described in detail in Sir Lewis Pelly's "Introduction to the translation of The Miracle Play of Hassan and Hussain" [Allen and Co.: 18] and he would refer those present who wished to follow the matter further to Sir Lewis Pelly's obscure but profoundly suggestive volumes. He had said enough to show that the popular life of India was in this way everywhere filled with divinity; and that was the only explanation he could suggest of its universal artistic attractiveness, and of the complete content of the people in it,—which neither wars, nor plague, nor famines could perturb or confuse. He had found it very much the same in Catholic Europe. He spent the year of the Great War of Giants in France, and was living in Boulogne at the time of the death and burial of Monsigneur Haffrangue, when the apple orchards around about were in their full bloom. Many present would know Boulogne, the new town flush with "the streak of silver sea," and the old town above, still high cinctured by its mediæval wall, and the old apple trees planted on the ramparts, with the Cathedral Church of Our Lady of Boulogne brooding over all. About three hours before the interment half a mile or more of sable cloth, from 4 to 5 yards broad, and diapered over with large ivory-white *fleurs de lys*, was rolled out from the Cathedral stores, and hung above the shop, and other ground-floor, windows, along the length of every street to be traversed by the funeral procession. This was all on foot,—the ordinary clergy in black and white, a small knot of church dignitaries in robes, and nodding hat tufts, of various colours, and a few civil and military functionaries in official uniforms. Nothing could have been more unprepared, yet nothing more real and impressive in its simple, and,—alike in picture and in sentiment,—most expressive pomp. With that cloud of apple blossoms, in all their lavish loveliness, enwreathing the whole scene, it was as if an illumination out of some old Froissart had been suddenly reproduced in the landscape, and life, and religious feeling of 600 years ago. Here, in answer to a question from the audience, Sir George Birdwood said they might make sure of the spectacular success of the Coronation Durbar at Delhi. The present Viceroy was a statesman of artistic sensibility, and quick, instinctive sympathy with everything in the vernacular culture of the people of India that had contributed to develop their unique historical personality, and being also a man of powerful intellect, with the disposition to do things magnificently, and wielding autocratic power, he might be relied on to make the approaching Durbar altogether worthy of them, and of the traditions they cherished of the glories of the reigns of Vikramaditya and Salivahana. Continuing his remarks, the Chairman said that one of the circumstances of his life he always recalled with pride was his having occupied that Chair when, in 1892, the illustrious father of Miss May Morris read his paper before the Applied Art Section on "The Wood Cuts of Gothic Books." The Great Exhibition of 1851 inflicted two cruel blows on our prosperity and reputation: it betrayed our manufacturing processes, and our commercial organisations, in a phrase, our "trade secrets," to the whole world of ravening competitors, whose envy, hatred, and malice has ever since dogged our footsteps in all our international relations; and it also cosmopolitanised and so degraded and deformed our national industrial arts. The great work of William Morris was to lead back our arts and crafts to their traditionary methods, and "motifs," and style; and he happily lived to influence by his direct teaching and example almost every department of our decorative arts,—painted tiles, stained glass, furniture of all uses, woven, and dyed, and printed stuffs, embroidery, domestic metal work, and book printing, book illustration, and bookbinding; and now at last our jewelry is beginning to feel something of his indirect influence,—once again proving that death has no power over those whose work is deathless. It was, indeed, by the death of William Morris that the true purpose and dimensions of his life work were first made manifest to us, and he is now recognised throughout the civilised world as the greatest art master of the Victorian Age, who stamped his glorious personality on every English craft and household art of the 19th century. It was an honour to them all to have the daughter of William Morris among them that evening, and most cheering to them to see and hear for themselves with what rare intelligence, fire, and easy mastery she was sustaining the traditions of her father's genius, as a true and faithful priestess of his work and fame. It was a double honour to himself to have presided on so pleasant and happy an occasion, and he respectfully begged leave to move a most hearty vote of thanks to Miss May Morris for her brilliant and fascinating paper; and for her own merits, and their reverence for the name and memory of William Morris, they would all second the motion, and vote it unanimously.

Miss MORRIS briefly replied.

Miscellaneous.

ELECTRIC POWER PLANTS IN THE PACIFIC STATES OF AMERICA.

In a paper recently read before the New York Electrical Society, by Dr. F. A. C. Perrine, a full account is given of the progress made in utilising the waterfalls and rivers along the Pacific slopes of the Rocky Mountains for the development of electric energy and its transmission over long distances for use in town lighting, and for motive power in the mining and manufacturing districts of the Pacific States.

Power transmission at constant current was first used on the coast, a 10,000 volt motor circuit being installed in San Francisco, and long distance transmission performed to the neighbouring mines. Later on long distance single phase alternating lighting was installed at Pomona, in Southern California, and single phase power transmission at Bodie. A similar plant was established at Walla Walla, in Washington State, and the multiphase system was first successfully adopted at Redlands. The first commercially successful transmission of electric power for mines and mine working was proved at Nevada City.

One of the most remarkable installations is that at the Snoqualmie Falls, Washington State. These Falls are situated in the Cascade Mountains, amidst most beautiful surroundings of river, gorge, and magnificent spruce forests. To provide the power-house here, the startling plan was adopted of excavating a cavern within the very rock over which the Falls plunge. This was rendered necessary owing to the spray from the Falls, which made it impracticable for any power-house to be established at their foot, and to have gone further down the river to a suitable site, would have involved greater expense than the present work. To reach the cavern in which the power-house is situated, entrance is made by a little cabin near the fore bay to a shaft, in which an elevator works, and which also contains the penstock, and 250 feet below the surface the machine-room is reached, in which are located six 1,500 kilowatt generators.

This plant was one of the first in which aluminium was used for its transmission lines. The lines are carried over difficult mountains, and through continuous forests of dense spruce and fir, which have been carefully cleared along the route to prevent the trees falling and interrupting the service.

Current is transmitted at 60 cycles to the cities of Seattle and Tacoma, where it is employed for lighting and for operating the railways. In Seattle the current is transformed by rotary convertors, but in Tacoma motor generators are used for this purpose and regulation obtained by a combination of synchronous and induction motors.

At Portland in Oregon the Falls utilised for working the machinery are subject to considerable fluctuation in volume, causing a severely varying head of pressure. To meet this difficulty the water-wheels and their hydraulic connections have had to be located much below the surface of maximum high water. At the season of great floods these Falls become almost insignificant rapids owing to the fact that the river at this point is confined between narrow rocky walls which allow of no overflow to the country beyond.

As no water-wheel could be designed capable of operation at full load and full speed with its normal head reduced from 60 to 80 per cent., large auxiliary wheels were provided arranged for belting to the shafts of the high head wheels, and to prevent high water from flooding the machinery, the building is made watertight from its foundations to three feet above the machine floor, and the lighting of the wheel-pits and belting space is provided by regular marine watertight screw port-holes. The armatures of the generators are attached to the vertical shafts of the high head wheels, and though in appearance the machines seem similar to those employed at Niagara, they are essentially different in revolving an internal armature in place of an external field. No attempt at parallel running is made, each generator feeding an independent line and supplying an independent service, either for lighting or for driving rotary convertors or synchronous motors, only one machine being coupled to any one generator. The original transformer equipment consists of banks of small units, and in spite of the complexity of the system as a whole, the original equipment is still in satisfactory service.

Further southward, in California, power plants begin to multiply, many having historical importance. The traveller in the mountains finds, far away from any appearance of civilisation, a well-kept canal or ditch, as it is technically termed, and following it for a few miles a low constant, and not unmusical note reaches his ear, and he learns that beneath his feet along the river bank lies one of those power plants ceaselessly generating current to be used in the neighbouring mines or distant cities.

The type of plant employed in nearly all cases is the same, the water power being supplied from a ditch varying from 5 to 50 miles in length, producing by its combination with the rapids along the river a head of from 300 to 1,500 feet, which is utilised by impulse wheels running at high speed and directly connected to the generators. These feed step-up transformers, and the high voltage current is transmitted for use over distances of from 5 to 200 miles and more.

Two of the principal Californian plants are those of the Standard Electric Company and the Bay Counties Power Company. Both these plants are long distance extensions of originally small undertakings.

Thirty years ago the Blue Lakes Company was incorporated for the purpose of supplying water to the mines in Amador County, and a ditch system of over 80 miles in length was constructed and successfully worked until the extinction of hydraulic mining rendered the undertaking more or less unprofitable. At this time Prince Andre Poniatowski came to California with a plan for combining small mining properties, and working them under more economical conditions. Incidental to this plan, he joined the Blue Lakes Company in building an electric plant on the Mokelumne River, where a head of 1,000 feet was available, and distributed the power to his mines. The success of this experiment, and further experience, led him to form the Standard Electric Company of California, which announced its intentions of transmitting power to the City of San Francisco, a distance of 110 miles. The plan proposed by the contractors, the Stanley Manufacturing Company, and now being carried out by them, involves the operation of 50,000 volts. The work has been in progress for the past four years, and power will not be supplied until the works are entirely completed, so that continuity of service is assured. In the first place, storage reservoirs in the high Sierras have been provided for an estimated storage of water amounting to 150 days, equal to the maximum dry period to be anticipated. These reservoirs, situated at elevations of from 6,000 to 8,000 feet above the sea level, in Alpine County, are provided with dams built in a thorough manner and cared for regularly. From these reservoirs the water is allowed to flow down 50 miles of the river to a diverting dam near West Point Bridge, where it is taken out of the river and carried along in a ditch about 25 feet wide and 5 feet deep to the crest of a hill above the power plant, from whence a wood stave pipe line 3,000 feet long leads to where a sheer descent can be made to the power plant itself, which is supplied by a head of 1,450 feet with a length of pipe of only 3,600 feet. As the flow of water in 20 miles of ditch cannot be regulated to suit the variations in load likely to be experienced by the plant, in order that the ditch may be used with a constant flow, a reservoir is provided into which any surplus water that may be flowing above that demanded by the load can be retained until a peak load period is reached, when the surplus above the ditch capacity is supplied from the reservoir. With a hill so steep as that down which this pipe is laid no reservoir site is available between the plant and the ditch, and the bold plan has therefore been adopted of storing the water in a valley across the mountain, and leading it back to the power-house through a tunnel 3,000 feet in length.

For greatest efficiency the water-wheels should run at half the spouting velocity of the water, which in this case is as high as 18,000 feet per minute. The peripheral speed of the wheels amounts to 9,000 feet per minute. They are 11 feet in diameter and run at 240 revolutions. Two wheels, each of 1,000 kilowatts capacity, are attached to each generator, and five sets of wheels and generators are installed. From the power-house the lines lead over hill and dale to the city of Stockton thence to the little town of Mission San Jose on the shore of San Francisco Bay, a distance of 100 miles from the power plant. At this point the lines diverge north and south and are here controlled as a centre of distribution for the system. They then run north about 28 miles to Oakland, and south to San Jose, around the Bay and up to the north to San Francisco, making a total transmission in distance of 154 miles, six miles more than was originally contemplated, as it had been intended to cross the hills direct to Oakland, and cross the Bay from there direct to San Francisco, but Government permission could not be obtained to do this by overhead lines, and the expense of submarine cables would have been more than that of the plan adopted. The change in the plans was further justified by the fact that all round the Bay are towns, large and small, which form customers for the power.

In Oakland, San Jose, and San Francisco, storage batteries have been erected as an additional safeguard against interruption, and motor generators have been installed for charging them, which are capable of being used in such a manner that should accidents happen along the line, both the alternating and direct current service can be maintained by the batteries.

The Bay Counties Power Company, whose principal power-house is at Colgate in the Sierra Mountains, is a growth of two small plants within 30 miles of each other, one, the plant erected to supply Nevada City, and the other the Yuba Power Company, using a fall in one of the irrigating ditches, and returning its tail water to the ditch for further distribution in irrigation. Further developments have since been made, and water powers secured wherever reasonably available. Since these plans were completed the Bay Counties Company has made a contract with another small company, the Folsom Company, who supply Sacramento and whose plant was deficient in capacity. Accordingly a line was built from Colgate to that city 60 miles in length, which is operated at 40,000 volts supplying current in conjunction with the 10,000 volt plant 20 miles away at Folsam. The two plants work in parallel with one another. Later on the Bay Counties Company built, and is now operating, a line 152 miles in length from the plant at Colgate to the city of Oakland. To reach this city the navigable straits of Carquinez had to be crossed through which the deepwater grain ships go from San Francisco Bay to the port of Porta Costa. These straits are bordered with high hills. On these hills towers were erected and cables stretched with a span exceeding 4,000 feet. As the sub-stations and lines to this point belonging to the Standard Power Company were ready for operation that company has bought a large amount of power from the Bay Counties Company, which it transmits south to Misson San Jose and thence to Stockton, San Jose, and up around the Bay, as far as Redwood City, effecting a total transmission for the Bay Counties Company of 198 miles to San Jose, 200 miles to Redwood City, and 218 miles to Stockton. These distances are met successfully in everyday practice, and interruptions to supply have been very few.

Up at Colgate the generators run day and night, supplying power to these distant points, and the result is not only successful from an engineering point of view, but also financially. These plants operate lights, mines, railroads, flower mills, &c., and with such satisfaction that the only difficulty is to supply the increasing demands for power made upon them.

At Pomona a number of plants are installed for supplying power to Los Angeles. The first plant erected was a single-phase lighting plant, the current being transmitted a distance of 28 miles at 10,000 volts. From this beginning plant after plant was installed, until, in 1898, the plant of the Southern California Electric Company was built, with a transmission of 80 miles at 33,000 volts.

Shortly after this plant was constructed a consolidation of interests took place, and now there is daily effected parallel running to a remarkable extent. Alternators of both revolving field and revolving armature types, of different makes, are running in parallel and supplying together power for railroads and lights in conjunction with steam-driven plants. The successful manner in which all the problems have been met along the Pacific coast is entirely due to the fact that they have been well engineered, well installed, and well operated.

THE PRODUCTION OF HEMP IN THE PHILIPPINE ISLANDS.

The principal industry of the Philippine Islands is the production of hemp. The southern part of Luzon Island, and all other islands to the south, are given up largely to hemp cultivation, all of the product being shipped to other countries to be manufactured. It is the industry which supports a large proportion of the population of those islands where it is extensively grown, and, according to the opinion of those most familiar with the trade, there is no danger of an over-production and a consequent decrease in the selling price of this product, at least so it is stated in an official report on the trade of the Philippines recently issued by the United States War Department at Washington. Manila hemp is used in the manufacture of cordage of a superior class. For ships' purposes it is superior to any other material considering its cost and wearing qualities. The cultivation of hemp, while carried on extensively in the Philippine Islands, is conducted in a most primitive manner. It is found nowhere else in the world, and while it is now extensively cultivated, and large tracts of land are planted in it, it is still found growing wild in certain portions of the island, and in quantities which make it worth while to gather it for shipment. Hemp, or "abaca" as it is called in the Philippines, is a product of a species of the plantain tree. In its wild state it grows to a height of eight to twelve feet, but under cultivation it grows to a height of fifteen to twenty feet, with a trunk from eight to twelve inches in diameter. The stalk of this tree is in appearance something like the banana plant—merely a collection of fibrous leaves, which are closely joined together, and which can be easily cut with a single blow of a sharp knife. The tree is allowed to mature, which requires about three years, this being dependent upon the soil and the elevation of the land upon which it is planted above sea level. When the tree has attained the proper age, it is cut down, and divided into long strips, which are put under a large knife, weighted with a lever, and under which the strips are drawn. This separates the stalk and juice from the fibre, and the latter is then spread out on the ground to dry. This work is all done at the plantations, and after the abaca or hemp is sufficiently dried, it is gathered up and taken in bullock carts to the nearest waterway, and shipped to some port, where it is made into bales ready for export. The production of hemp is carried on extensively by natives, by Spaniards, and by foreigners. The export business is practically all in the hands of foreigners—mostly English, Belgian, and German houses.

MINERAL SPRINGS OF SIBERIA.

The entire region of the Trans-Baikal is said to be rich in hot mineral springs, and the natives of that region, as well as the Russian settlers, are believed to be familiar with the medicinal properties. Hitherto, nothing has been done in the way of scientific investigation and proper classification of its waters. The lands in which the springs are situated, fall under the title of Crown lands, and are under the jurisdiction of the Ministry of Agriculture. Recently Professor Zalessky, a well-known Russian expert, was sent to the Trans-Baikal country to examine, analyze, and report upon the most important springs along the line of the great Siberian Railway. The most popular springs are the Turkinsk Hot Springs in the Bayuseni district, near the "Holy" or "Rich," Lake Baikal. There are many wonderful legends connected with the cures reported, and they go back to the earliest times. The iron springs, near Darassunsk, south of Chita (where the new Manchurian line joins the main road), are well known locally and are patronized. Then there are the Makovieff Springs, between Chita and Nerchinsk. With the opening up of the new railway and the beginning of work on the Circum-Baikal line, it is expected that many invalids who now seek the baths of Obama in Japan, will avail themselves of the facilities nearer home. These ancient medicinal springs may not equal those of New Zealand, but they are far more important than has been previously estimated. In Kamchatka, there are many mineral springs and geysers, but with the exception of the Serebriamkoff Springs, none of them have any accommodation for visitors.

Journal of the Society of Arts,

No. 2,589. Vol. L.

FRIDAY, JULY 4, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 40 of the Society's By-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31ST, 1902.

Dr.	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1901				2,029	0	1
,, Subscriptions	5,389	13	0			
,, Life compositions	735	0	0			
				6,124	13	0
,, Dividends and Interest				592	15	6
,, Ground Rents				657	14	3
,, Examination Fees				1,920	17	0
,, Clothworkers' Company (Donation to Examination Prize Fund)				30	0	0
,, Conversazione, 1901 (sale of tickets)				122	0	0
,, Advertisements				410	10	6
,, Sales, &c.:—						
"Cantor" Lectures	26	17	9			
Examination Programmes	32	10	11			
Fees for use of meeting-rooms	46	4	0			
Journal	121	1	9			
Miscellaneous Sales	4	9	8			
Howard Lectures	12	0	0			
Reports of the Committee on Leather for Bookbinding	11	3	9			
				254	7	10
,, Bequest of £50 by the late W. A. Herring, Esq., less duty				45	0	0
,, Donation towards the expenses of the Committee on Leather for Bookbinding				25	0	0
				£12,211	18	2

Cr.	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	829	17	3			
Insurance, Gas, Coal, House expenses and charges incidental to meetings	312	9	5			
Repairs and Alterations	80	13	5			
				1,223	0	1
,, Office:—						
Salaries and wages	2,121	0	2			
Stationery, Office Printing and Lithography	408	3	3			
Advertising	118	11	0			
Postage Stamps, Messengers' Fares, and Parcels	289	7	4			
				2,937	1	9
,, Library, Bookbinding, &c.				74	2	10
,, Conversazione (1901)				449	13	9
,, *Journal*, including Printing and Publishing				1,779	10	0
,, Advertisements (Agents and Printing)				191	8	0
,, Examinations				1,884	16	1
,, Medals:—						
Albert	23	12	3			
Society's	46	12	9			
				70	5	0
,, Memorial Tablets				7	9	6
,, "Owen Jones" Prizes				35	9	0
,, Drawing Society's Prizes				19	9	0
,, "Cantor" Lectures				198	16	3
,, Juvenile Lectures				39	19	2
,, "Howard" Lectures				43	6	4
,, Sections:—						
Applied Art	60	0	0			
Foreign and Colonial	47	3	11			
Indian	66	6	3			
				173	10	2
,, Committees (General Expenses)				22	13	3
,, Committee on Leather for Bookbinding				16	17	0
,, Investment of Life Compositions for the year, in War Loan				735	0	0
				9,902	7	2
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1902				2,309	11	0
				£12,211	18	2

LIABILITIES.

	£	s.	d.	£	s.	d.
To Sundry Creditors	547	8	11			
,, Examiners' Fees	636	1	6			
,, Examination Prizes and Medals	121	0	0			
,, Sections:—Applied Art, Foreign and Colonial, and Indian	170	0	0			
,, Accumulations under Trusts	464	1	8			
				1,938	12	1
,, Excess of assets over liabilities				22,979	12	1
				£24,918	4	2

ASSETS.

	Amount of Stock, &c. £	s.	d.	Worth on 31st May 1902. £	s.	d.	£	s.	d.
By Society's Accumulated Funds invested as follows:									
Consols	1,976	5	7	1,909	11	7			
Canada 4 per Cent. Stock	500	0	0	510	0	0			
South Australia 4 per Cent. Stock	500	0	0	535	0	0			
N.S. Wales 3½ per Cent. Stock	530	10	1	551	14	6			
N.S. Wales 4 per Cent. Stock	500	0	0	580	0	0			
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217	0	0	277	15	0			
Queensland 4 per Cent. Bonds	1,500	0	0	1,575	0	0			
Natal 4 per Cent. Stock	500	0	0	590	0	0			
Ground Rents (amount invested)	10,496	2	9	10,496	2	9			
New River Co. Share (New)	100	0	0	410	0	0			
National War Loan	1,992	17	1	1,987	17	4			
							19,423	1	
	18,812	15	6						
,, Subscriptions of the year uncollected				600	12	0			
,, Arrears, estimated as recoverable				185	0	0			
							785	12	0
,, Property of the Society (Books, Pictures, &c.)							2,000	0	0
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1902							2,309	11	0
,, Do. on Deposit (against interest on Trusts)							400	0	0
							£24,918	4	2

FUNDS HELD IN TRUST BY THE SOCIETY.

	£	s.	d.	
Dr. Swiney's Bequest	£4,477	10	0	Ground-rents, chargeable with a sum of £200 once in five years.
"John Stock" Trust	100	0	0	Consols, chargeable with the Award of a Medal.
"Benjamin Shaw" Trust for Industrial Hygiene	133	6	8	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	192	2	1	,, ,, ,, ,,
"Fothergill" Trust	388	1	4	,, ,, ,, of a Medal.
J. Murray, in aid of a Building Fund	54	18	0	,,
Subscriptions to an Endowment Fund	562	2	2	,,
Dr. Aldred's Bequest	220	2	3	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
Dr. Cantor's Bequest	2,450 2,695	0 11	0 3	Bombay and Baroda Railway Stock Ground-rents } Interest applied to the Cantor Lectures.
"Owen Jones" Memorial Trust	423	0	0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
"Mulready" Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Amount to cover accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.
	£14,655	9	9	

TOTAL OF INVESTMENTS &C., STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

	£	s.	d.	£	s.	d.
Ground Rents (amount of cash invested)				£17,669	4	0
Consols				3,626	18	1
Metropolitan Railway 4 per Cent. Perpetual Preference Stock				500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock				2,450	0	0
Canada 4 per Cent. Stock				923	0	0
South Australia 4 per Cent. Stock				605	16	0
New South Wales 3½ per Cent. Stock				530	10	1
New South Wales 4 per Cent. Stock				500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock				2,170	0	0
Queensland 4 per Cent. Bonds				1,500	0	0
Natal. 4 per Cent. Stock				500	0	0
New River Company Share (New)				100	0	0
National War Loan				1,992	17	1
Cash on Deposit with Messrs. Coutts and Co.				400	0	0
Society's Accumulated Funds	18,812	15	6	£33,468	5	3
Trust Funds held by Society	14,655	9	9			

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

OWEN ROBERTS,
OWEN TUDOR BURNE, } *Treasurers.*

HENRY TRUEMAN WOOD, *Secretary.*
Society's House, Adelphi, 20th June, 1902.

KNOX, CROPPER, AND CO., *Auditors.*

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-eighth Annual Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 9th July, at 4 p.m.

(By order of the Council),
HENRY TRUEMAN WOOD,
Secretary.

MEDALS.

The Council have awarded the Society's Silver Medal for the following papers read before the Society during the session 1901-2:—

At the Ordinary Meetings:—

To J. GORDON PARKER, Ph.D., for his paper on "Leather for Bookbinding."

To HERBERT STONE, for his paper on "The Identification of Wood, and its Application to Scientific and Commercial Purposes."

To PROF. GEORGE FORBES, F.R.S., for his paper on "Range Finders."

To PROF. ROBERTS BEAUMONT, M.I.Mech.E., for his paper on "Recent Inventions in Weaving Machinery."

To E. PRICE-EDWARDS, for his paper on "Sound Signals."

To J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E., for his paper on "Electric Traction: London's Tubes, Trams and Trains."

To MAJOR-GENERAL SIR JOHN F. CREASE, K.C.B., for his paper on "Ceuta and Gibraltar."

To EDWARD T. SCAMMELL, for his paper on "The Timber Resources of the Australian Commonwealth."

To H. WARINGTON SMYTH, for his paper on "Boats and Boat Building in the Malay Peninsula."

In the Indian Section:—

To PROFESSOR WYNDHAM R. DUNSTAN, F.R.S., for his paper on "The Coal Resources of India."

To THOMAS WILLIAM HOLDERNESS, C.S.I., for his paper on "The Indian Famine of 1899, and the Measures Taken to Meet it."

To THOMAS JEWELL BENNETT, for his paper on "The Past and Present Connection of England with the Persian Gulf."

In the Colonial Section:—

To COMMANDER B. WHITEHOUSE, R.N., for his paper "To the Victoria Nyanza by the Uganda Railway."

To W. T. PRESTON, for his paper on "The French-Canadian Relationship to the Crown."

In the Applied Art Section:—

To HALSEY RICARDO, for his paper on "The Architect's Use of Enamelled Tiles."

To REV. HENRY THURSTON, S.J., for his paper on "The History of the Rosary in all Countries."

CONVERSAZIONE.

The Society's annual Conversazione was held in the Gardens of the Royal Botanic Society, Inner Circle, Regent's-park, on Tuesday evening, 24th ult.

The Reception was held by Sir William Preece, K.C.B., F.R.S., Chairman, and the following members of the Council:—Professor Francis Elgar, LL.D., F.R.S., the Hon. Sir Charles W. Fremantle, K.C.B., Robert Kaye Gray, Sir Owen Roberts, D.C.L., Carmichael Thomas, Sir John I. Thorneycroft, F.R.S., and Sir John Wolfe-Barry, K.C.B., F.R.S.

A concert of instrumental music was given by the String Band of the Royal Artillery (conductor, Cavalier L. Zavertal) in the conservatory. A selection of music was performed by the Band of the Scots Guards (conductor, Fred. W. Wood) on the West Lawn, and a performance by the Red Hungarian Band (leader, Herr Gyula Hegedüs) on the East Lawn and in the Club-house.

There was a special collection of growing and cut roses and other flowers by Messrs. W. Paul and Son, in a marquee on the West Lawn. Among the roses shown was a new pink and white single rose, named the Waltham Rambler, just introduced by Messrs. Paul; and the Royal Botanic Society's Exhibition of Rhododendrons, by Messrs. Waterer, of Bagshot, was also on view.

The gardens were illuminated by coloured lamps, and the exhibitions of flowers were illuminated by the Kitson incandescent oil light.

The number of visitors attending the Conversazione was 2,047.

JOURNAL ADVERTISEMENTS.

From the present date, all arrangements connected with the advertisements in the *Society of Arts Journal* will be in the hands of Messrs. Walter Judd, Limited. All communications, therefore, referring to advertisements should be addressed in future to Messrs. Walter Judd, Limited, 5, Queen Victoria-street, E.C.

PROSPECTIVE RAILWAY DEVELOPMENT IN BRITISH EQUATORIAL AFRICA.

By C. Steuart Betton.

From the Mediterranean Sea, southward through Egypt and the Sudan, a regular service of railways and steamboats is now available for some 2,470 miles inland* to Gondokoro, the northern frontier post of the Uganda Protectorate; whilst 735 odd miles by the Uganda Railway and steamboats on the Victoria Nyanza, brings Entebbe, the administrative capital of Uganda, within a four days journey from the Indian Ocean.

Now Entebbe, 55 miles due east of Gondokoro, is 275 miles in a direct line S.S.E. by S. of it, and a project to connect this comparatively inconsiderable distance between the two places need no longer be considered chimerical.

A recently constructed cart road leads from Entebbe, *via* Kampala and Hoima, to Butiaba, a Government post on the Albert Nyanza, and from thence it is possible to descend the Nile (Bahr el Jebel) by boat, as far as Nimule, a post a few miles north of the junction of the Unyama with the former river.

The one steel boat at present on the lake is quite inadequate for existing requirements, and a light-draught steamer might at once be advantageously employed, as it will be needed for future development of lake commerce.

Beyond Nimule, further progress by water is barred by a series of rapids, which extend for over 100 miles to Rejaf, and the sole available means of transport is by porters.†

Between the Belgian stations of Rejaf, Lado, Kero (or Kiru), on the west bank of the Nile, a small paddle steamboat, the *Van Kerckhoven*, plies; but at present there is no object in the Sudan Government steamers proceeding further south than Gondokoro, on the east bank,* which is the last place touched at. Moreover, the short distance, some eight miles, that might be saved at all seasons by water-carriage south of Gondokoro need not here be considered, as a more suitable site for a station in British territory is not likely to be found in that distance.

Sir Harry Johnstone, in his report on Uganda, [Africa No. 7 (1901), page 19] suggests that a good cart road be constructed from Dufile to Gondokoro, ultimately to be followed by a light railway.

Apparently Dufile is a *lapsus calami* for Nimule, as the former was a station of Emin Pasha's on the west bank of the Nile, and is now abandoned, and furthermore, it is in Belgian territory.

It may be doubted whether, even if the cart road were constructed, transport animals would succeed in this climate. At an elevation of only 1,500 feet above sea level, in the Nile Valley the heat is intense, and the few horses and donkeys that have been introduced apparently lived but a short time.

Previous experience of the appalling mortality of transport animals, in somewhat similar country in British East Africa (where the deaths caused by tsetse fly formed but a small proportion of those from various kinds of cattle diseases), warrant one in assuming that such mode of transport could be but a costly and temporary makeshift. The Bari natives possess some cattle, but these are remarkably small, and unsuited to draught purposes.

The question then arises as to the possibility of a railway to connect up the 100-mile link in the chain of communications to Gondokoro.

From Nimule the present caravan track skirts the east bank of the Nile, crossing the formidable Assua River,† and, for 40 miles nearly to Mugi, porterage by native carriers, even of the lightest loads, is extremely difficult.* The river (Nile) here runs through a deep one-sided gorge, said to be 135 feet in the narrowest part, where a high mountain range, rising 2,000 feet above it, comes close down to the west bank; forming a barrier of escarped hills of Gneiss and Mica Schist, which gradually diminish, and finally break out into cones as they recede to the north-west.

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* Alexandria—Luxor, 547 miles, 4 ft. 8½ in. gauge; Luxor—Shellal, 141 miles, 3 ft. 6 in. gauge (Egyptian Railways). Shellal—Tewfikiah (Wady Halfa), 125 miles, Cook's or Sudan Government Steamboats; Wady Halfa—Khartum, 576 miles, 3 ft. 6 in. gauge, Sudan Military Railway; Khartum—Gondokoro, 1,081 miles, Sudan Government Steamboats and Gunboats.

† Porters are rarely available either at Nimule or Gondokoro, and a traveller reaching either place is likely to find himself stranded, until negotiations (through the administrative officer at the stations) can be concluded with the Bari chiefs for a supply of carriers from village to village. The incessant delays, endless "shauri" (palavers), and general discomfort resulting, can be but faintly imagined by those unacquainted with the Nilotic tribes. It is preferable to engage Baganda porters at Kampala, and to march the entire distance between that place and Gondokoro. Travellers by the reverse route would have to advise their arrival two or three months beforehand, and arrange for carriers to be ready to meet them at the latter place.

* The "post-boat" stern-wheeler *Amkeh* monthly plies between Khartum and Kanisa (6° 46′ North Lat.), a post for the sudd-cutting party; and thence a light draught gunboat carries the mails to Gondokoro. The accommodation on either boat is limited, but suffices for present needs.

† After its main tributary, the Atappi, has joined it, and ½-mile above its junction with the Nile, it is 60 feet wide, a series of deep pools with ridges of granite rock running across it, strata uptilted nearly vertical. In flood said to be 80 feet wide, 14 feet deep, with swift current; liable to very sudden flushes. High ground on either bank.

On the east side, very broken ground is encountered, and a range of hills, 1,000 feet or more above the river, is noticeable; but, unfortunately, I had no opportunity of ascertaining how far inland this extends.

Apparently this range forms the water parting between the Nile and River Gomoro (or Khor kit). This latter river runs north-west, and after 50 miles enters the Nile opposite Rejaf, being there 500 yards across, between low banks, with a sandy bed of decomposed granite, partly covered with water a few inches deep, and liable to heavy floods.

Beyond Mugi the country may be described as undulating, in places covered with bush jungle or grass, with patches of fine timber, and dotted with low ranges of hog-backed hills and granite outcrops, presenting, however, few engineering difficulties.

But it is certain that in the neighbourhood of Nimule heavy work will be unavoidable; for, in a radius of 10 miles, the Assua, and its large tributary, the Atappi, the Unyama, and the Jeifi rivers (*vide* p. 13) discharge enormous floods (after heavy rains) into the > - shaped elbow of the Bahr el Jebel at this point, and much broken ground may be reckoned on.

Assuming that a reconnaissance of the country between Nimule and Gondokoro will prove that a line is practicable (*i.e.*, the cost be not excessive), it is obvious that railway plant and material, for however light a line, could not be brought up through the Sudan.† Furthermore, neither labour nor food is obtainable in the portion of the Bari country under consideration. The natives, fairly numerous, are none too friendly, and generally have been on the verge of starvation during recent years.

Considered by itself, the idea of a short detached piece of line here is not practical. Should, however, the light line westward from Entebbe, as suggested by Sir Harry Johnstone, to open up the Ruwenzori district, be considered, we may examine the possibility of branching off from the latter at some convenient point, and, striking northward, of crossing the Somerset Nile near Fajoa, of continuing east of the Bahr el Jebel toward Nimule, and ultimately to Gondokoro.

Such a line might be feasible. The gauge of the railway need not be considered here, but, looking forward to possible distant-future developments, it may be questioned whether a 3 ft. 6 in. gauge would not be advisable at the onset.

As regards the engineering difficulties likely to be encountered, it may first be observed that the Victoria Nyanza is 3,775 feet above sea level, the Albert Nyanza 2,170 feet, and the Nile at Gondokoro approximately 1,550 feet. Heavy gradients, therefore, are not to be expected.

It is noticeable that, as one leaves the Victoria Nyanza for the Somerset Nile the valleys widen out, and the hills of red marl, shale, or metamorphic rock lessen, till, with a few exceptions, they gradually disappear and the country presents the appearance of a huge plain gently sloping to the north and intersected by wide swamps and numerous small streams. Long waterless tracts are nowhere met with.

Generally speaking, it would be an easy country to survey but for the intensely long rank grass which covers much of it. In the dry season this grass is fired and an extended view then only is obtained.

Through Uganda and Unyoro most of the swamps are choked up with rushes, papyrus, and grass, and it is only occasionally that a current is noticeable. The time of year (October) at which I traversed the country is generally considered to be the middle of the second period of maximum rainfall, but in no case did it appear that any of the swamps would present much difficulty, and the treacherous and bottomless quagmires, mentioned by some travellers as occurring in Uganda, were not encountered by this route.

The native roadbuilders' attempts at bridging these swamps consist of carrying acrcss a foot or 18-inch bank, leaving a small opening at the lowest part of the valley, where a few logs are thrown transversely to the road, and then covered with brushwood and earth. So long as these are kept in repair they admirably effect their purpose; but, except near the capital, these roads are often in a rotten condition.

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* The track apparently has been unimproved since the Bari fishermen first utilized the Hippopotamus, and other game paths to convey their catches of fish to neighbouring villages. For a caravan route to an European settlement it is execrable.

† Even after the completion of the Suakim-Berber line, the distance from the Red Sea would entail transport of 470 miles by railway and 1,081 by boat. The exigencies of the Sudan, for many years to come, will require expenditure on improvements of its waterways rather than on construction of railways south of Khartum.

I can recall no instance where a 5-feet bank would not have been amply sufficient for any contingency; and, as regards the opening, 10-feet girders on screw-piles, with the toe of the bank protected by rubble stone, would probably be found better than culverts; for the difficulty of excavating foundations, during most months of the year, would be considerable.

Presupposing the railway to be started in the vicinity of Entebbe (which is situated on the south end of a peninsula that is practically an island), it is possible that a suitable harbour may be found on the western side of the Murchison Bay. Kampala is six miles due north of this bay, and the native road thither, as is customary in Uganda, runs straight over the low-lying hills, all of which might easily have been avoided by slight *détours*.

Striking north-west of Kampala, and following the native road which leads through Kunguni, Kalasa, and Kisibika, over low undulating country, a range of low hills (through which the River Maanja runs) is conspicuous on the south-west. Many of the valleys passed are swampy, in which cases corduroy bridges are employed.

At Kisibika an extended view is first obtainable, and one is surprised at the general aspect of the country, which is strongly suggestive of the Taru Desert (East Africa) at certain seasons.

Crossing the Maanja River where it is flowing swiftly, 20 feet wide and 6 inches deep (Nov., 1901), a mile of marsh land is met with. The track then keeps about 10 miles west of the latter river, and, except for a few swamps, no obstacle is met with up to the Kafu River, in Unyoro; crossed at a point due south of Masindi. The papyrus choked stream, 15 feet wide, has no perceptible flow, and for miles to the north of it there is low lying ground.

However, this river would probably be crossed near the abandoned station of Fort Lugard, and, by following the water parting between the Kafu River and the Albert Nyanza, the granitic hill country round Massindi would also be avoided. With the exception of the major bridges required for the Maanja and Kafu Rivers, the country traversed strikes one as being extremely easy for road or railway projects.

It is probable that the Kesokwa, Waja, and other rivers flowing into the Albert Nyanza would require major bridges; but the Waja only I crossed north of Masindi, where its branches were 5, 30, and and 6 feet wide, at intervals of two miles apart, where it has a rapid fall, is evidently subject to heavy floods, and the main stream is between high banks.

On nearing Fajao the caravan track leads over very broken ground, and, a mile from the river, follows a spur, with deep ravines on either side, leading sharply to the Somerset Nile. The former European post, consisting of a few grass huts, is perched on an isolated rock hill, which commands the ferry.

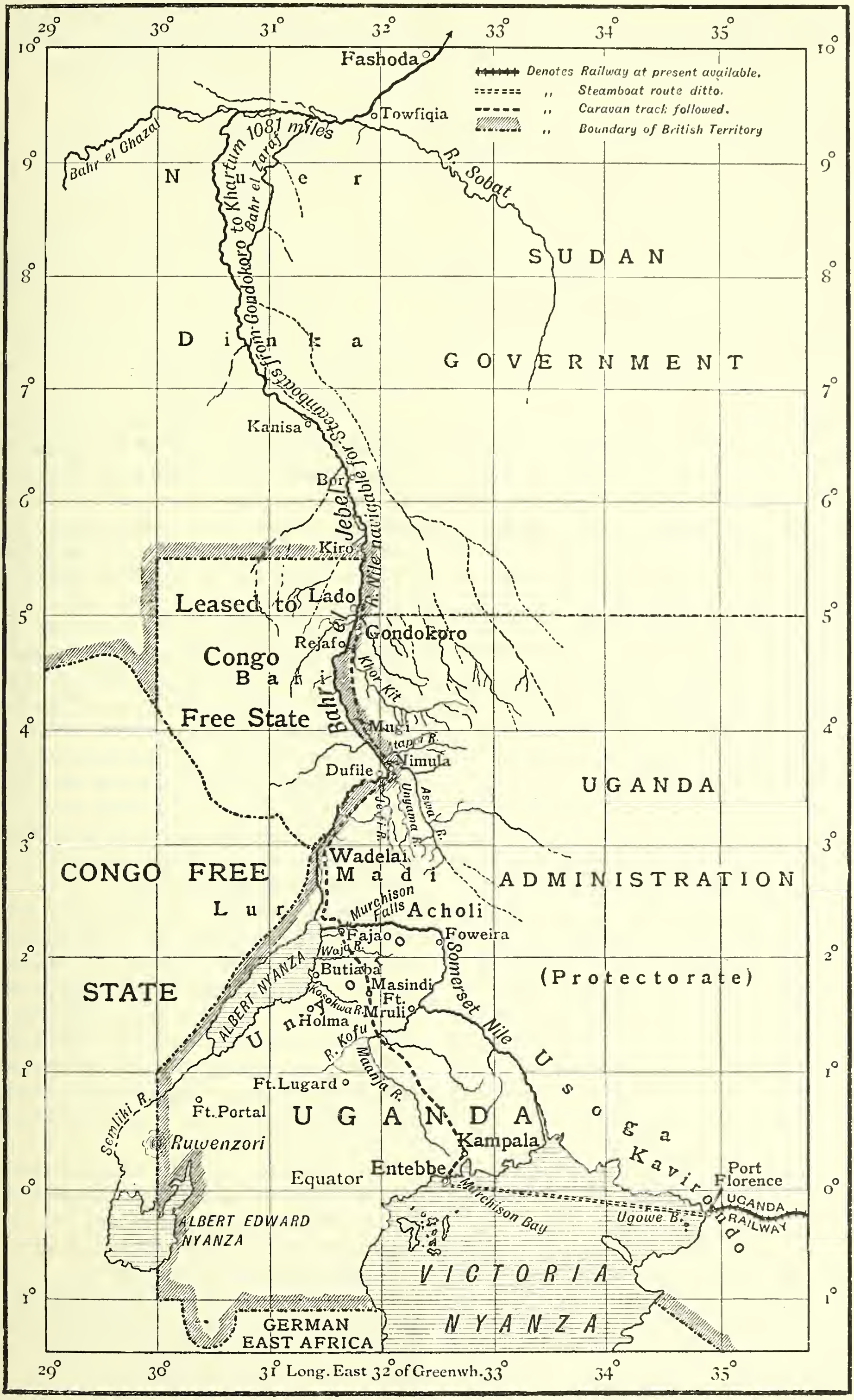
Westward of Fajao the hills rapidly widen out and disappear, and a broad expanse of low lying ground borders the river, which is a mile in width, gradually increasing to five miles or more as it nears the lake. On the east side of the station several more isolated rock masses are conspicuous, and three-quarters of a mile further are the Murchison Falls.

It is evident that the river has cut its way back, leaving these masses of gneiss as "witnesses." The cliffs, 200-300 feet high, are composed of rocks belonging to the Archæan series, and the specimens I brought home have been identified by Mr. George Prior, of the Natural History Section of the British Museum, as biotite gneiss, mica schist quartz, and garnetiferous mica schist.

At the site of the falls, which are probably over 100 feet in height (reputed 120 feet), the river, ¼ mile wide, after several rapids, takes a sharp bend to the north-west, and then again west, and, rapidly narrowing, tumbles over a rock ridge 10 feet high, then over another 5 feet ridge, and finally enters a cleft through one side of a mica-schist-rock witness, similar to those previously mentioned.

The sides of the cleft, which varies in width from 20 to 30 feet (on meeting Major Delmé Radcliffe two days later he informed me the minimum width measured by him was only 18 feet), are absolutely sheer. Down this shoot the river rushes, an unbroken mass, for 150 feet, apparently then meets with some obstacle, probably a harder class of rock, through which it is endeavouring to force its way, and, hitting this with tremendous force, a "back wave" is created. Meanwhile, ere this can break, the mass of water following on has forced its way over the obstruction with considerable turmoil, and often in a mass of spray.

Another 250 feet is traversed through the



Scale of Miles

0 50 100 150 200 250 300

continuous cleft ere the water tumbles into a huge basin below, followed hard after by the back wave, thus causing the peculiar irregular sound of the falls so noticeable even at Fajao.

On the south side the ledge above the cleft is of considerable extent and evidently marks the site of the river bed in former times. Hollowed out in the ledge are some large "pot-holes," one of which is 15 feet in diameter and 10 feet deep (another 6 feet in diameter) now filled with clear water. Behind this ledge (quarter mile wide including both sides of the cleft) the hills rise in tiers, but lack of time alone prevented a further examination of the river, more than half mile above the falls.

This spot, however, struck me as admirably adapted for a crossing, and the American type of trestle viaducts would be especially adaptable. Probably trestles of 100 feet height would be sufficient at the actual crossing, but as I was unable to examine the north side of the river at this point I know nothing as to the possibilities of the approach there.

Apparently there exists a plateau extending some distance northward, along which the line would run, avoiding the branches of the Tengi River, and crossing the Achwa near its sources. The latter river, a few miles ere it enters the Bahr el Jebel, was 50 feet wide and waist deep, between banks a few feet high.

From the Somerset Nile onwards the aspect of the country rapidly changes. We are crossing the Eastern watershed of the Bahr el Jebel, and usually are within ten miles of it. The drainage runs from east to west—wide swamps are rarer, streams and rivulets more common. Long rolling downs of grass (still dense rank grass as before encountered, and often six to twelve feet high, but the natives are now, in November, already firing it)* are succeeded by patches of bush jungle. Probably the entire country was so covered; then, destroyed by fires, the bush jungle was replaced by cultivation; intertribal wars, &c., followed by famines, have reduced the numbers of natives, and huge areas of once cultivated land are now the haunts of antelope and other game.

The heat is much greater, but not so depressing, for the atmosphere is intensely dry. The natives also have changed. From the well-clothed natives of the ancient Kitara kingdom, we pass to the stark-naked Nilotic races: Acholi (closely resembling and probably allied to the Kavirondo), Lur, Madi, and, finally, Bari; amongst all of whom, the bastard form of Arabic spoken by the Nubians (*i.e.*, the Sudanese) takes the place of Kiswahili, the *lingua franca* of East Africa.

No river of any importance (for the two crossed by the caravan track north of Wadelai,* would be probably avoided by the railway, and others crossed are only 2 to 4 feet wide), need not be mentioned, till the Zukar River is reached; 30 feet wide, 3 feet deep, it flows swiftly between low banks to the North-West, passing close to a bank of magnificent primæval timber.

A few miles north of the Zukar, the track crosses the water parting between the Bahr el Jebel and the River Jeifi, and distant views of wide rolling plains are obtained. The track crosses another river (? Dirikwa), three channels three to four feet wide and three feet deep, between banks 15 feet high, and then keeps along the west side of the watershed of the River Jeifi, crossed where it is 30 feet wide, 2 feet deep, with a branch 6 feet wide and 2 feet deep, between low banks.

Ten miles further the River Unyama is met, 30 feet wide, 2 feet deep, also with low banks, after the abandoned station of Affuddu is passed. The track then turns sharply north-west, and on a granite hill overlooking the Nile, and commanded by hog-backed hills on the east, the existing Government station of Nimule is reached. The feasibility of a railway beyond this point to Gondokoro, has already been discussed.

In conclusion, it may be expected that the line will be one of easy curves (except possibly part of the last section) and gradients; water supply everywhere ample, and fuel, except in a few localities, generally plentiful.

It having been previously mentioned that the suggested railway could not be built from the Gondokoro end, there remains the question of its construction from Entebbe.

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* Apparently a road cleared 10 feet wide is, in less than a year, entirely overgrown except for the 10-inch track hardly kept open by passing traffic. This track is often completely obscured, especially after heavy rain, by the overhanging grass; and after a few miles march in the early morn, ere the dew has been dispersed. the entire caravan is wet through to the skin. The difficulty of constructing the road originally is so considerable (the only implement used by natives for grass clearing being a pointed heart-shaped hoe with a short handle—Uganda pattern), that it seems remarkable some European machinery has not been attempted. A light reaping machine, drawn by a couple of oxen or mules, to cut 5 feet swathes, would keep open the main roads throughout the country, and reduce the difficulties of transport, which are always sufficiently onerous during the greater portion of he year.

* The present station of Wadelai is on the east bank of the Bahr el Jebel, close to its junction with the River Omee. The original station of Emin Pasha's was on the west bank.

Now, the first portion of the line would pass through the densely populated part of Uganda proper, where a large supply of cheap labour can be obtained locally.

The hut-tax, introduced two years ago, of Rs.3 per annum, is payable in coin, kind, or by one month's labour on Government work. The Baganda largely avail themselves of the latter method, and as they provide their own food, public works are being cheaply constructed.

Allowing that, on starting the railway, increased demand for labour will tend to raise prices*, and that food will have to be provided for the workmen when beyond the confines of their own districts, it will still be evident that, in comparison with the imported† labour necessarily employed on the Uganda Railway, the cost would be slight: probably only one-quarter of the latter.

The present Government rate in Uganda may be taken as the minimum for unskilled labour; but, as an example of extremely low wage, I may instance when an Indian merchant at Kampala agreed to supply me with 33 porters for the six weeks journey to Gondokoro at Rs. 11 per *capitum*. (This included cost of registration, beads of various kinds for food barter *en route*, and commission. The porters, on their return, would be free to carry loads for the contractor, who would thus make a handsome profit. The actual wage for which the porters hired themselves out to the contractor was Rs. 4 for the three months—or 1s. 8d. per mensem; yet large numbers of porters are being hired at this small wage.)

It must be borne in mind that the administrative officers in the various districts, are already, through the native chiefs, directing the construction of roads, &c. All that would further be required would be the formation of a central labour bureau, under some officers well known to both Baganda and Banyoro, who would deal solely with the chiefs. His picked staff would deal with the organisation, on which everything would depend.

Commencing with a few hundreds of labourers, it would be necessary as the work proceeded, to insure continual drafts being forwarded to maintain the ultimate standard, say 10,000, required. The question of food supply would also fall on this bureau; entailing high organisation and a complete mastery of detail; and the strain on the Uganda administration would undoubtedly be great.

The difficulty of providing food beyond the confines of Uganda and Unyoro would also be very considerable.

One important point may be noted—the labourers would be, advisedly, working directly under their chiefs, in their own country or in adjoining territories, with the natives of whom they are on friendly terms. Constant friction between imported foreign labour and natives would be altogether avoided, and a police force, except for the purpose of guarding stores, &c., unnecessary.

Moreover, the contact of the comparatively civilised and intelligent Baganda with the savages of the Upper Nile Province (Acholi, Lur, Madi, Bari) would have a far-reaching beneficial effect. Trading caravans of Baganda and Banyoro are already constantly proceeding to and fro between Entebbe and Gondokoro, and it is by no means uncommon to meet *en route* isolated unarmed parties of two or three men. Not only would there be no disturbance among the tribes passed through (among the Bari especially the advent of earthwork parties would be beneficial), but these latter would soon join in the construction of the earthworks. They are keen traders, but at present their chief desire is for brass, &c., wire, and beads, and such like commodities. Large numbers at first might be attracted by the prospect of food alone; for, generally speaking, from the Somerset Nile onwards, the tribes have usually been famine-stricken during recent years. (It is, however, probable that as the country becomes more settled, and a cycle of "wet" succeeds one of "dry" years, there will be ample food for passing caravans; but no more can be expected.)

Another point in the employment of natives of this portion of the country is that the difficulties of housing (also transport) are reduced to a minimum. Even when on the march, they daily construct grass huts, at which work they are adepts; and when a lengthened stay in one place is intended, wattle houses, with rain-proof thatch, are quickly constructed.

In the case of the Baganda, personal belongings, on a three months' trip, are reduced to a change of bark-cloth clothing

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* *e.g.* on the East coast, where labour of any kind has always been scarce and high prices for even unskilled labour prevailed. Increased demand of recent years has forced up prices to absurd rates, which are (or were in 1901) still maintained. A repetition of this, in Uganda, it is to be hoped, will be carefully avoided.

† Punjabi coolies, on three year agreements, had to be provided with Indian rations, also imported. Their passage to and fro, housing, and incidental expenses which would not be incurred with Baganda labour, raised the cost of construction to a very high figure.

(*mbugu*) and a cooking-pot. Nor do they possess much more when at home.

It is unfortunate that the natives of (former) Kitara have in recent years been decimated by wars, famines, and disease (at this moment "sleeping sickness" is rampant), and that from various causes the birth-rate is decreasing. The peasantry (*bakopi*) of Uganda is undoubtedly the finest material we possess in British East Equatorial Africa for the future development of the country.

The questions of the advantage of the railway, its cost, probable commerce, &c., have not been touched on. They are beyond the purport of the present paper, which is to comment on the feasibility, from a railway engineer's point of view, of a line through that portion of the country (440 miles) traversed in a five weeks' march between Entebbe and the Sudan frontier, in October and November last.

[Unless otherwise stated, by the "width" of rivers is implied the width of the water or flooded area at the point at which the caravan track crossed it. Naturally, the fords selected by the natives are usually at points where the river is broad and shallow, and the banks low. Notes of every stream, river, and swamp were taken for the information of later travellers by this route, but further examination of most rivers was impossible in the limited time available on the daily march.

The small map attached is compiled from the map of the Nile, by Stanford, in 1896, and of the Bahr el Gebel in Sir William Garstin's Report on the Nile (Egypt No. 2, 1901).

For further details, see map of Uganda, issued by the War Office, in November, 1899.]

DISCOVERER OF COAL GAS.

It is proposed to erect, by public subscription, a monument in honour of Professor Jan Pieter Minckelers (to whom is now attributed the discovery of coal gas) in his native town of Limburg, Holland. Minckelers was appointed Professor of Natural Philosophy at the University of Louvain in Belgium in 1772, when he was 23 years old. In 1783, in the course of investigations aiming at the discovery of a cheaper gas than hydrogen for inflating balloons, he produced coal gas, and described it in a memoir, published at Louvain in 1784. He made it from coal in a gun-barrel, and observed that it was formed freely and quickly, and was inflammable. In 1785, he lighted his lecture-room at Louvain with coal gas, and apparently continued to use it there for years. Assuming these statements to be correct, it would appear that he anticipated both Lebon, the Frenchman, and William Murdoch, in the discovery of coal gas — if the generally accepted dates of their discoveries are correct. The monumental stone on Murdoch's old house at Redruth, in Cornwall, states that he invented gas there in 1792. A committee, of which the Mayor of Maastricht is chairman, and Heer P. Bolsius, the manager of the gas works at 's Hertogenbosch (Bois le Duc), and Heer J. W. H. Bauduin, the manager of the gas works at Maastricht, are secretaries, has been formed for the purpose of furthering the scheme for the erection of a monument at Maastricht. The *Journal of Gas Lighting* (from which this information is obtained) contained in the number for Jan. 7th last particulars of Minckeler's claims.

The manuscript of the memoir on "Inflammable Air Extracted from Different Substances," printed at Louvain, in 1784, referred to above, was on view at the Gas Pavilion of the Paris Exhibition in 1900. The manager of the Italian Gas Company at Turin, after studying the documents at the Gas Pavilion, decided that a bust of Minckelers should be placed above the main entrance to the new offices of the company. On one face of the building, above the upper windows, are busts of Lebon, Murdoch, Clegg, Winsor, and Welsbach; on the other face, are busts of Lavoisier, Dumas, Regnault, Bunsen, Schilling, and Berthelot. The place of honour, however, in the centre, between the two faces of the building, is conceded to Minckelers.

ST. LOUIS EXHIBITION AND CONGRESS, 1904.

Information has been received that the United States Congress has amended the law which provided for the opening of the Universal Exposition at St. Louis on May 1st, 1903, by deferring it for one year. One of the principal reasons for this is that the plans originally fixed to commemorate the purchase of the great territory of Louisiana have been much enlarged.

To show the extent of the buildings, it may be pointed out that four of those already in course of construction take in a sweep of more than one mile. The fifteen palaces, designed for the industries and the arts collectively, will hold the new century's first exhibit of the world's resources and output; and will, at the same time, present a bird's-eye view of the growth and progress of all peoples and all countries.

Up to the middle of June the money available for the St. Louis Universal Exposition, including State and National appropriations, amounted to 20,000,000 dols., or something over £4,000,000. Exhibitors ask for time, upon the plea that they are not able, on such short notice, to design and prepare the special exhibits necessary. They need a year to plan and to put their ideas into form, and another to carry them out. That is, if they are to carry out the purposes of the management and to include among their exhibits the latest models, processes, and discoveries.

The postponement until 1904 has also been made, in order that, while the buildings were planned to be complete at the time originally fixed, and the progress already made assured success, they may now receive greater attention in the matter of construction, and the same conditions also apply to the ornamentation of the grounds; these will be planted, and the year's additional growth will give them a finish as well as a completeness otherwise impossible.

While the postponement was under discussion, assurance was received from nearly all the leading foreign countries, and from many of the States of the American Union, that the postponement would be welcomed. More time was also needed for making and perfecting arrangements for the congresses and meetings, now such important features of all universal exhibitions. Meanwhile work has been going on steadily. The commission from France has already visited St. Louis, and the Chief Commissioner from Canada, Mr. William Hutchison, has also arrived and made his preliminary arrangements. The Dominion has made a first grant of 125,000 dols. for its buildings and exhibits. Four of the largest buildings, covering a space of nearly a mile, are already under construction, while the work upon the grounds is proceeding as rapidly as possible.

PRACTICAL APPLICATION OF SCIENTIFIC EDUCATION IN GERMANY.

It has been asserted in some quarters that the commercial rise of Germany has been largely due to the results of the Franco-Prussian war, which put money into its coffers, and stimulated the energies of its people. Perhaps much of Germany's phenomenal success of the last quarter of the century was due to this event; but in order to gauge accurately the nation's capacity and aims, it is necessary to look further back than 1870-71, for technical education had its beginning in Germany long before the Franco-Prussian war. Sixty years ago Liebig had fifty students working in his factory, and all the German Universities have had their own chemical laboratories since 1827. To-day, there are in German factories 4,500 thoroughly trained chemists, besides more than 5,000 assistants, whose brains are constantly at work upon the problems of improving processes, lessening the cost of production, &c. The United States Consul at Stuttgart says that the sugar industry illustrates the practical application which the Germans make of the educational system. In 1840, 154,000 tons of beet-root were crushed, from which 8,000 tons of raw sugar were produced, showing about 5½ per cent. of raw sugar extracted from the root. Twenty years later, 1,500,000 tons were treated which produced 128,000 tons of sugar, or about 8 per cent. Last year about 12,000,000 tons were crushed, which produced 1,500,000 tons of raw sugar, raising the per-centage to 13. This advance is said to be due entirely to scientific treatment. The production of dry colours, chemicals, and dyes in Germany shows a corresponding increase in production and dividend-paying capacity. Comparing the statistics of the dyeing industry of the year 1874 with those of 1898, it is found that notwithstanding the fact that prices in 1898 were considerably lower than in 1874, the net income in 1874 was about £1,200,000, and in 1898, £6,000,000. The great increase of earning capacity is due largely to the constant labour of trained men, who by application of their technical knowledge have so cheapened production, that they have succeeded in getting this trade out of the hands which previously controlled it. Another illustration is found in the manufacture of artificial indigo, a chemical process for making which, was discovered in Germany about thirty-five years ago. It was started with less than forty workmen. It now employs over 6,000 men, and has a staff of 148 scientific chemists. The Germans have also discovered a method for obtaining ground slag from steel processes, which is used as a fertilizer. The Krupp gun industry is another instance of this progress, too familiar to need description, but the latest is the discovery by a German chemist, by the name of Giebler, of a process of hardening steel, which makes it, it is said, 14 per cent. stronger, 50 per cent. lighter, and one-third less costly than the Krupp, Harvey, or Boehler steel. The inventor will not sell the secret of the process to any foreign manufacturer, but will retain it for the benefit of Germany. This, if true, will give the country an enormous advantage in naval matters, for with a lighter hull, lighter machinery, and lighter guns, a very much higher rate of speed can be produced for a given consumption of fuel, which means also an extended steaming distance. A great advance has also been made in the scientific instrument industry. The value of the exports from Germany of scientific instruments in the year 1898 was about £250,000—three times what it was in 1888—and the work gave employment to 14,000 people. These are a few of the many instances showing the close connection between the scientific education of the German people and their commercial prosperity. The conclusion to be arrived at from the foregoing are not so much academic as economic and practical. In Germany, a young man is called upon to decide early in his career whether he will take a classical or a scientific course. If he decides to take the latter, he goes into the "Real Schule," or lower scientific school, to be moved thence to the "Real Gymnasium," or scientific high school, and thence to the "Polytechnicum," or institute of technology, which is separate from the Universities. In this course he has no Greek, and only a moderate amount of Latin, but he has the science of engineering, mathematics, modern languages, history, and a mixture of practical and theoretical training in various technical branches, with frequent excursions for the purpose of inspection of work in factories and public enterprises. The faculties of these institutions keep in touch with the manufactories, and when capable young men graduate, they easily find situations. This is also true of the technical high schools, of which there are twenty-four, which likewise have courses in engineering, architecture, drainage, irrigation, modelling, drawing, chemistry, modern languages, history, &c. The Imperial Department of Commerce and Industries has been of great assistance to the German manufacturer. It has been an intermediary between the educational and practical work, guiding the one, sustaining the other, and providing information to the manufacturer, first in beginning his industry, later in expanding it, and finally in finding an outlet for his surplus.

SAKE BREWING IN JAPAN.

Saké, the national drink of Japan, as wine is of France and beer of Germany, is manufactured almost entirely of rice, and differs from beer chiefly in having a larger per-centage of alcohol and smaller proportions of dextrose and dextrin. The manufacture of saké includes two processes—the production of koji, which the saké brewer uses much as a beer brewer does malt, and often prepares in independent factories, and the combination of the koji with steamed rice and water, under conditions calculated to induce fermentation. For the manufacture of koji, it is essential that a constant and rather high degree of heat should be maintained for several days, and to secure this condition chambers are cut in the ground 15 or 20 feet below the surface, and these are approached by a long narrow passage entered by a shaft, so that a cold draught may not reach the working chambers. The rice is brought to the factory husked, but not cleaned, and is placed in a wooden mortar sunk in the ground. Over the mortar is a heavy wooden hammer attached to a lever. The hammer is raised and then permitted to fall by its own weight upon the rice, causing the grains to rub upon each other, thus removing the covering, and usually the embryo of the seed also. In most cases the lever is worked by hand power, but in some instances steam or water power is used. The pounded mass is separated into three portions—the whole grains, the broken grains, and the bran, only the former of which is used for the best koji. The loss in this operation varies from 25 to 40 per cent. The whole grains, says the United States Consul at Yokohama, are placed in a tank covered with water and occasionally trodden, the water being frequently changed. After being thoroughly washed the grain is permitted to soak over night and is then steamed by being placed in a large tub with a false bottom covered with cloth. The tub s placed over an iron boiler filled with water, the steam from which passes through an opening in the rue bottom of the tub and permeates the mass of ice, heating the grains, killing the embryos, if any remain after the pounding, and causing the grain to become gelatinised. After this treatment the grain should be flexible, of a horny appearance, and uniform throughout, The mass, now called "mi," is spread on mats and cooled with about 29° Centigrade (84° Fahrenheit), when a yellowish powder called "tane," and consisting of the spores of a fungus, is mixed with it. The spores are first thoroughly mixed with a small quantity of rice and this mixture is scattered over the whole mass while spread out on the mats, and well stirred. The mixture is then carried to the cooler parts of the underground chambers and left for 24 hours, when it has a temperature of 26° Centigrade (78° Fahrenheit). It is now placed in the innermost part of the underground chambers and spread out in a very thin layer on wooden trays. After 12 hours the contents of each tray are collected into a little heap on the tray and left for four or five hours, during which time the temperature rises considerably and the vegetation of the spores binds the grains of the mass together with the mycelium. To prevent overheating it is again spread out on the tray, and after cooling a few hours brought into heaps again, and afterwards worked with the hands for some time. While in the innermost chamber the temperature of the koji varies from 15° to 27° Centigrade (59° to 80° Fahrenheit), and the air in the chamber from 8° to 13° Centigrade (46° to 55° Fahrenheit). The highest degree of temperature in the koji is observed just before the masses are broken apart, and the lowest just before making up into heaps again. The chamber is not artificially heated, except at starting, after being disused for some time. The heat generated by the growing fungus is sufficient to maintain the temperature of the room, besides heating the rice, although the consumption of oxygen and generation of carbonic acid gas make it necessary to ventilate the room, and a current of warm air is constantly rising through a shaft at the front end of the passages, and being replaced by a current of pure cold air which flows along the floor of the chamber. In winter when the difference between the outdoor temperature and that in the chamber is considerable, this method of ventilation is found effective and satisfactory, and during the warmer part of the year the koji is manufactured in small quantities only, and the ventilation is of less consequence. Steamed rice, koji, and water are now mixed, and, after mixing, the mass is divided into six parts, so as to be more easily handled; each is placed in a shallow wooden tub, and worked by hand for two hours, care being taken to break the lumps, and render the mass of a smooth, even consistency. It is left for twenty-four hours, then stirred with paddles, and the different lots are emptied together into a large tub, which has a wooden lid, and is covered with matting to hinder the escape of heat. At this point in the preparation the treatment varies, some makers permitting it to stand for five or six days, while others proceed at once with the heating, which is the next step in the process. A tub 18 inches deep, and with a diameter varying from 12 inches at the top to 9 inches at the bottom, is filled with boiling water, tightly closed and suspended in the mash in the large tub, where it is frequently moved about, so as to agitate the mash, and bring all parts in contact with the heater. This is usually left for half a day, and then replaced by a fresh one, from five to ten tubs, or in some breweries even more being used. During this process the liquid attains a temperature of 23° Centigrade (73° Fahrenheit), or a little more, and the heat induces alcoholic fermentation. After seven days the liquid is transferred to the shallow pans, and permitted to cool until the fourteenth day, when this stage of the manufacture is completed, and the substance now called "moto" has a temperature of about 9° Centigrade (48° Fahrenheit). The process of fermentation resemble that of wine, in the fact that no ferment has been knowingly added by the brewer, and the question of the origin of the ferment, which developes very suddenly after heat is applied, has given rise to some discussion among scientists. The saké brewer judges of the progress of the "moto" by the activity of fermentation and the taste of the liquid, and uses it in the subsequent process, much as yeast is used by the beer brewer. About fifty-two gallons each of "moto," steamed rice and water, are now mixed with about fourteen gallons of "koji" in a large tun, and the mixture is stirred every two hours—after forty-two hours to three days the workman adds about seventy-eight gallons of steamed rice, about twenty-six gallons of "koji," and about one hundred and twenty gallons of water; it is divided into two parts, and the stirring is continued every two hours. After twenty-four hours, steamed rice, koji, and water are again added in nearly the same proportion to the whole amount as before, the quantity of water depending upon the alcoholic strength desired. At first, the liquid is divided among four receptacles, but after three days it is gradually collected into one large vessel, in which the fermentation goes on more vigorously for two or three days, and then lessens, the froth sinks, and after a few more days the product is ready for filtration. The liquid now consists principally of alcohol and water, with a small quantity of the unaltered rice grains suspended in it. It is put into long, hempen bags, which have been strengthened by being soaked in the juice of unripe persimmons. Each bag is filled about two-thirds full, fastened securely, and three or four hundred are placed in a press—a wooden box, furnished with an aperture below, and covered by a wooden plate, which fits inside the box, and is pressed down by a lever. A slight pressure is applied, and gradually increased to 1,200 or 1,800 pounds, and after twelve hours the cover is removed, the bags are turned over, and are again subjected to pressure for twelve hours. The alcohol in the residue is afterwards extracted by distillation. The filtered saké is still turbid, and is cleared by being permitted to stand until the suspended matter has settled, when the top is drawn off. The clear saké thus secured would not keep for more than a few days in warm weather, and before stored it is heated to a temperature of from 49° to 54° Centrigrade (120° to 129° Fahrenheit), and then, while still hot, transferred to the store vats. These are closed with lids, and sealed by pasting a strip of paper over the joint. Even with these precautions it is necessary to examine the saké frequently in warm weather, and when any signs of alteration are apparent it must be re-heated. On account of the difficulty of preservation, the whole of the winter's brewing is consumed within the year, even in the large breweries.

THE IRON INDUSTRIES OF GERMANY.

The principal iron ore deposits of Germany are situated in Silesia, Thuringia, Hanover, Lorraine, Westphalia, Saxony, and the Rhine province. There are about 1,500 mines or shafts in operation, which give employment to 40,917 miners. In 1899 the total output of iron ore was estimated at 17,989,700 tons, valued at £3,340,000. Of this amount 3,247,888 tons were exported chiefly to Belgium and France. In 1900 4,107,840 tons were imported into the German Empire, fully 75 per cent. coming from Sweden and Spain. The iron market in Germany underwent great fluctuations shortly after 1873. This was caused principally by over-speculation, and a change for the better was first noticeable about 1880 when the German Government took charge of the railways. The wonderful development of electricity as a motive power within the past ten years has made itself felt among the iron industries all over the Empire. Consul Harris, of Eibenstock, says that the present outlook for the iron industry in Germany is not bright. Manufacturers on the whole are not building new factories or enlarging the old ones. During 1900 the shipbuilding industry flourished as never before, but now even this shows signs of falling off. It is only in the Navy yards that the activity has continued unabated, the passage of the Naval Bill by the Reichstag in 1900 having created a demand for iron for fifteen years to come. In 1894 there were 208 iron foundries and smelting works in the German Empire which gave regular employment to 24,110 skilled workmen. It must be understood that these figures include only those employed in the actual production of raw iron from iron ores. In 1899, the total output of crude iron was 8,120,000 tons. These figures were exceeded during the same year by Great Britain, with 9,450,000 tons, and by the United States, with 13,840,000 tons. The other iron-producing countries of the world are as follows, the amount of their production in metric tons of 2,205 pounds avoirdupois, being placed in brackets against each:—France (2,525,000); Russia (2,500,000); Austria-Hungary (1,430,000); Belgium (1,000,000); Sweden (530,000); Spain (260,000); Japan (20,500); and Italy (12,400). Of the output of iron in Germany during 1899, only 6½ per cent.

was of the Bessemer process, while 55 per cent. was of the Thomas process. The manufacture of puddled iron in the Empire is on the decrease, but for welding purposes it is still much in use. In the valley of the Saar and in Peine-Ilsede, Germany enjoys very favourable conditions for the production of iron. One disadvantage in connection with the iron works situated in the Ruhr Valley, is the reshipment of ores from the Rhine to the different points of consumption. Consul Harris says that, after England, Germany is the most formidable competitor of the United States in the iron markets of the world. The depression in the iron industries of Germany is due in some degree to American competition. So keenly has this competition been felt within the past two years, that experts are urging German producers to exert themselves to the utmost to prevent American iron manufacturers displacing them in the markets of the world. The only means of averting this, it is claimed, is by technical education. In each of the nine technical universities of Germany, great attention is devoted to *Hüttenkunde*, or the art of smelting; and every year a corps of young men is sent out well prepared to take positions as managers, foremen, or in any capacity in the iron foundries and and smelting works of the Empire.

Obituary.

W. Ivison Macadam.—On Wednesday, 24th inst., Mr. Macadam, the chemical lecturer of the Royal College of Surgeons, in Edinburgh, was shot dead in his laboratory while conducting an experiment, by a porter of the College, named McClinton. He was the son of Dr. Stevenson Macadam, a member of many years standing of the Society of Arts, who died in January, 1901, and was succeeded by his son in the membership. Mr. Macadam was one of the best known Volunteer officers in Scotland. In 1882, as lieutenant, he sat at the first examination open to Volunteer officers, and was awarded special mention; and in 1887 he presented himself for the highest grade certificate in tactics, and was again successful. After having risen through the different commands to be colonel of the battalion, he was appointed brigade major. Mr. Macadam had recently been appointed to command the 2nd Scottish Provisional Battalion, and was to have left for London on the 25th June.

Sir James Bellett Richey, K.C.I.E., C.S.I.—Sir James Richey, late Member of Council, Government of Bombay, died suddenly in London, last Friday, 27th June. He was the son of the Rev. James Richey, rector of Nympton St. George, Devon. He was educated at Exeter College, Oxford, and was appointed, after examination, to the Bombay Civil Service in 1856. After serving in various capacities in the Service until 1879, he was appointed junior collector and magistrate at Ahmadnagar, and senior collector in 1880. In 1885 he became chief secretary to the Government in the political, secret, judicial, educational, and separate departments; in 1886, he was nominated an acting member of council, an appointment confirmed the following year; and in 1890 he retired from the Service. Sir James was elected a member of the Society of Arts in 1895.

Horace Seymour, C.B.—Mr. Horace Alfred Damer Seymour, Deputy Master and Comptroller of the Mint, died on Wednesday, June 25th, the day before the public announcement in the *London Gazette* that he had been made a K.C.B. He was born in 1843, the youngest son of Mr. Frederick C. W. Seymour and Lady Augusta Seymour, eldest daughter of the first Marquis of Bristol. He was educated at Marlborough and Trinity College, Cambridge, graduating in 1865. He entered the Treasury in 1867, and acted as private secretary to several Secretaries of the Treasury and to two Chancellors of the Exchequer. After a service of ten years, 1885-94, as Commissioner and Deputy Chairman of the Board of Customs, he succeeded the Hon. Sir C. W. Fremantle in the latter year as Deputy Master of the Mint. Mr. Seymour was elected a member of the Society of Arts in 1900.

Notes on Books.

The Earth in Relation to the Preservation and Destruction of Contagia: being the Milroy Lectures delivered at the Royal College of Physicians in 1899, together with other papers on Sanitation, by George Vivian Poore, M.D. F.R.C.P. London: Longmans, Green and Co.

Dr. Poore returns in this volume to the consideration of a subject which he has made his own, viz., the application of excreta to the soil, and has treated it in a very complete manner. The Milroy Lectures are contained in fourteen chapters dealing with the soil diseases caused by neglect of the principles of sanitation and also with agriculture, fertility of the soil, sanitation in Holland, as well as the great work carried out by the municipality of Manchester, who have reclaimed Carrington Moss, and are reclaiming Chat Moss by fertilising the ground with the organic refuse of the city. From the report of the Cleansing Department of the City of Manchester for 1897, it appears that 354,364 tons of refuse—very nearly 1,000 tons a day—were disposed of. Stated, in cartloads, there were of street sweepings, 61,248; of "Bell dust," 9,823; of rubbish, 97,658; and of night soil, 240,781; total, 409,510. Dr. Poore says, relating to this—"Assuming that the land is capable of receiving twenty tons of refuse per acre *in perpetuo*, the city will be in possession of a 'destructor' capable of consuming about 65,000 tons of organic refuse per annum, and each ton of refuse will ultimately return about a bushel and a-half of wheat, and 2½ cwt. of straw. This is surely better than burning, or fouling rivers."

In the subsequent papers, enteric fever, caused by pollution of public water supplies, and overcrowding, is again dealt with. Such points as recommendations as to Water Supply—What to do with Infected Material; Application of Excreta to well-tilled humus; the Sanitation of Camps—Flies and the Science of Scavenging; Milk in its relation to Health and Disease are also discussed.

Dr. Poore gives renewed warning respecting the dangers of the water-closet, and writes: "Dr. William Farr fully recognised that the cholera of 1849 and 1854, and the increase of diarrhœa were due to the water-closet, but he still hoped that the contents of a machine which rids the homes of filth need not necessarily poison our rivers and other sources of water. I confess I am very pessimistic on this head, as will be gathered from my remarks on the property of water to return to its source, and I feel convinced that unless we are guided by sound principles, all expenditure with a view to the prevention of enteric fever will be wasted." In the chapter on dietetic problems the author, while acknowledging the vast improvement in the dietary of the British public during the last two or three centuries, directs special attention to the modern attempts of chemistry to imitate nature, and warns the public that these imitation foods should be clearly labelled.

REMBRANDT: A CRITICAL ESSAY. By Auguste Bréal. London.

ROSSETTI: A CRITICAL ESSAY ON HIS ART. By Ford Madox Hueffer. London.

These are two volumes of a new series of handy little volumes published by Messrs. Duckworth, under the title of "The Popular Library of Art." Mr. Bréal's work has been translated from his French text by Miss Clementina Black. The position of Rembrandt as one of the greatest masters has long been established in the world of art, but of Rossetti Mr. Hueffer says, "We may call him a genius; we cannot call him a master." These volumes are fully illustrated and well got up.

THE HARMONY OF THE EMPIRE: being a Series of Sketches in Pictorial Geography of the British Possessions and Spheres of Influence. By the Author of "The Making of Europe" and "The Making of the British Colonies." Manchester: Abel Heywood and Son.

The author quotes Sir George Robertson as to the advantages of the study of political geography, which is described as the "practical application of the science of geography to the facts of national life," and suggests that his work carried out on these lines is supplementary to the ordinary text-book, and not a substitute. The subject matter is divided into six sections. The introduction explains Mercator's projection of the world, treats of sea power, trade routes, steam as a motive power, and coal stations. Notices of the various extra-colonial dependencies of Great Britain are given in groups, commencing with the Island of Ascension (discovered in 1501, but uninhabited for more than 300 years), and ending with Egypt.

LIEUTENANT-COLONEL JOHN HAUGHTON, COMMANDANT OF THE 36TH SIKHS, A HERO OF TIRAH. A Memoir, by Major A. C. Yate. London: John Murray.

The subject of this memoir had obtained a considerable reputation as an efficient regimental officer, and was expected to attain high rank in the Indian Army, but unhappily he was killed when on active service for the first time. Born in 1852, Colonel Haughton was edcated at Uppingham and Sandhurst. He obtained his commission in 1871, being one of the last ensigns ever gazetted to the Army. In 1876, Haughton joined the Indian Staff Corps, and was posted to the 10th Bengal Native Infantry. He first came under the notice of the higher authorities in 1885, when acting as a Brigade-Major, at the Ambala-Delhi Camp of Exercise, the most important manœuvres ever held in India. While holding this post, his Brigadier made a most favourable report of his work to the Government. Colonel Haughton served in various capacities until, in 1894, he was appointed commandant of the 36th Sikhs. Early in 1895, Colonel Haughton moved up with his regiment to the North-West Frontier, and when war broke out, in August, 1897, the 36th Sikhs were holding the fort on the Samana range. The author relates how Haughton distinguished himself as a leader during the sharp fighting of the Tirah campaign of 1897-98, and, having survived danger so often during the course of the expedition, lost his life in a "fruitless little foray," just when well-earned rest and reward seemed within his reach. Additional interest is lent to the narrative by a series of illustrations, reproduced from photographs taken mainly by Colonel Haughton himself.

General Notes.

HOWARD MEDAL.—The next competition for the Statistical Society's "Howard Medal" (1902-1903) will take place in the ensuing Session, subject to the rules laid down by the Society. The essays must be sent in to the Secretary of that Society on or before the 30th of June, 1903. In addition to the medal, a grant of £20 will be awarded to the writer who may be the successful competitor. The subject is, "The Alleviation of the Evils of Overcrowding by the Development of the Means of

Transit.'' The medal is of bronze, having on one side a portrait of John Howard, on the other a wheatsheaf, with suitable inscription.

Patents, Designs, and Trade Marks.—The report for the year 1901 of the Comptroller-General of Patents, Designs, and Trade Marks, which has been issued as a Parliamentary paper [178], states that the receipts from patent fees were £210,187, an increase of £6,047 as compared with 1900; from design fees, £3,432, an increase of £338; and from trade mark fees, £10,506, a decrease of £493. The surplus of receipts over payments was £107,291. The number of applications for patents received in 1901 was 26,777, as compared with 23,924 in 1900. The total number of specifications received was 34,399, an increase of 3,187, or 10·2 per cent. Dealing with inventions patented in 1900, the Comptroller states that the diminution in the number of specifications for that year is largely due to the continued decrease of inventions relating to cycles, but the titles of the applications lodged in 1901 indicate a considerable revival of inventive activity in both cycles and motor-cars during the latter half of last year. All the classes relating to electricity, except galvanic batteries, show an increase. Discussing the trend of invention in 1901, the Comptroller says that last year the attention of inventors was specially directed, as in 1900, to the subject of electric traction. The protection of the public from accidents due to broken wires was an object which occupied many minds. Motor-cars showed a considerable increase, especially as regards cars propelled by oil motors. The experimental trials of airships and submarine boats led to a number of applications for patents relating to these subjects. The Act regulating the sale of intoxicating liquors to children, passed in the last Session of Parliament, prescribed the use of "corked and sealed receptacles" by licensed victuallers, and towards the end of the year many applications were made for devices intended to comply with this requirement. Among other applications, obviously suggested by various occurrences of the year, were cases for preventing vibration in "tube" railways, spark guards for locomotives, and a "penny-down-a-slot" yacht race.—*Times.*

Electric Railways in Switzerland.—The old-fashioned diligence which up to the present time has been the means of transportation between the smaller towns and villages of Switzerland, which are off the lines of railway, is being rapidly superseded by the electric railway, and the day is not far distant when most of the towns of the country will be so connected. A short time ago an electric line was opened connecting Aarau with Schöftland, a distance of about ten miles. Until the opening of this line the time spent in making the journey by diligence was one hour and ten minutes; now, including stops at villages along the line, the time occupied is forty minutes. A company, according to Consul Morgan of Aarau, is seeking a concession from that place to Menziken, on the border of the Canton of Lucerne, and this will be joined by a line running from the city of Sursee northward, thus making an electric tramway connection for a distance of about thirty miles. Still another line is projected to run from Aarau to Frick—a most important plan, as it will place Aarau in direct communication with Laufenburg, Säckingen, and other towns in the Rhine Valley. The length of this line will be about thirty miles. The power to be used by these different roads will be derived from the waterfalls of the country.

Manufacture of Rosaries in the Tyrol.—In the parishes of Mieming and Rietz, the members of nearly every household are engaged in the preparation of rosaries, through the stringing together of beads. Every person of the female sex, old or young, spends her spare time in this manner, and the number of such workwomen in Mieming may be estimated at 140, while Rietz may be said to contribute 40, and Barwies 30, to the approximate total of 310 persons employed in the Tyrol. The employers of this labour are, in the majority of cases, tradesmen residing in Innsbruck. The materials are procured from France and Germany. The workwomen are paid by the piece, and receive for stringing a dozen rosaries of the ordinary kind, from 10 to 13 kreutzers (2d. to 2½d.), while, in the case of those which require more delicate handling, as much as 40 kreutzers (8d.) per dozen is paid, after the cost of all spoilt material has been deducted. The employers dispose of the rosaries, to a certain extent, in their own places of business, but a great many are sent to various parts of the country, the chief trade being done with Hungary. Many of the workwomen are engaged in the manufactories at Telfs, and these may be seen stringing beads to and from their work. The earnings of these workwomen vary from 80 to 160 crowns (£3 7s. 6d. to £6 15s.) per annum.

German Artifical Clay.—Artificial clay, according to recent German reports, is receiving increased attention abroad. This ceramic novelty, which is used for the manufacture of artificial stone, tiles, gutters, &c., is composed of sand, chalk, cement, liquid glue, and petroleum. The substances are mixed in certain quantities, and a clay-like mass results, which can be formed at pleasure, and acquires an excellent degree of hardness by being subjected to heat. The artificial clay can be employed in a variety of structures; tiles of different form and sizes are made of it. They have a perfectly even surface, and sharp edges, are fireproof, and resist the influence of the weather; they furthermore absorb no moisture. The clay is also used for the manufacture of artificial stone in all colours. Tests with this clay have been made at the Technical Experimental Station at Charlottenburg, and the results have been pronounced very favourable. As the substances are easily mixed without the aid of machinery, the United States Consul at Frankfort says that the smallest builders can use the process, and so obtain structural decorations at a low price.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments, during the past year, and also for the Election of Officers, was held in accordance with the By-laws on Wednesday last, 9th inst., at 4 p.m., Sir William Henry Preece, K.C.B., F.R.S., Chairman of Council, in the chair. The Council, acting under the provisions of By-law No. XLIV., postponed the date of the meeting from Wednesday, June 25th, to Wednesday, July 9th, as the Coronation of the King was fixed for the following day. (See notice ante p. 569.)

The Secretary read the notice convening the meeting, and the minutes of the last annual meeting.

The Chairman nominated Surgeon Lieut.-Colonel J. Ince and Mr. John Jewell Vezey, scrutineers, and declared the ballot open.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Anstruther, Sir Windham Robert Carmichael, Bart., Carmichael-house, Thankerton, R.S.O., N.B.
Armstrong, Richard, Saul-street Soap Works, Preston.
Barrow, Ernest G., M.Can.Soc.C.E., City Engineer, Hamilton, Ontario, Canada.
Birch, John de Gray, J.P., Umtali, Rhodesia, South Africa.
Braidwood, J. Q., 18, Exploration-buildings, Commissioner-street, Johannesburg, Transvaal, South Africa.
Brodhurst, Mrs. Thomazine Mary, 57, Upper Berkeley-street, Portman-square, W.
Coldstream, W. A., B.A., 69, West Cromwell-road, S.W.
Darroll, George, 16, Hout-street, Cape Town, South Africa.
Dixon, Frederick Thomas, B.A., Multan, Punjab, India.
Dixon, William Basil, Hong-Kong and Whampoa Dock Co., Limited, Hong-Kong, China.
Douslin, W., Bulawayo, Rhodesia, South Africa.
Edwards, Ernest William John, Las Minas de San Albino, Ocotal, Nueva Segovia, Nicaragua, Central America.
Elstob, Arthur, Durban Club, Durban, Natal, South Africa.
Fox, William R., L.R.C.S., L.R.C.P., York-house, Brunswick-street, North Fitzroy, Melbourne, Victoria, Australia.
Grenfell, Arthur P., Nilambur, South Malabar, Madras, India
Halsted, Professor George Bruce, The Neomon, 2407, Guadalupe-street, Austin, Texas, U.S. America.
Harkness, Rear-Admiral William, U.S.N., 90, Mercer-street, Jersey City, N.J., U.S. America.
Hill, Cyril Francis, Wardenhurst, Wanstead, Essex, and 308, West Ferry-road, Millwall, E.
Hill, Edmund L., The South Wales Electrical Power Distribution Company, Royal Chambers, Queen-street, Cardiff.
Jones, Benjamin Franklin, Pittsburgh, Pennsylvania, U.S. America.
Khan, Raja Sayid Mohammed Jafar Ali, Pandrawal State, District Bulandshahr, U.P., India.
Lambart, A. O., East London, Cape Colony, South Africa.
McConnel, James Henry, Cressbrook, Queensland, Australia.
Mackinnon, Alan, 2 Clive Ghaut-street, Calcutta, India.
Miller, William, Equitable Coal Company, Limited, Calcutta, India.
Muller, Frank, Oudtshoorn, Cape Colony, South Africa.
Noordin, M. N. M., Bukit Merah, Province Wellesley, Penang, Straits Settlements.
Osler, Professor William, M.D., F.R.S., F.R.C.P. Johns Hopkins University, Baltimore, Maryland U.S. America.
Owens, Thomas G., 28, Victoria-street, S.W.
Pearson, Sam Garforth, Axim, Gold Coast Colony, West Africa.
Pickstone, H. E. V., Lekkerwijn, Groot Drakenstein, Cape Colony, South Africa.
Preston, Sidney, A.M.I.C.E., Lahore, India.
Reid, Harry A., P.O. Box 140, Johannesburg, Transvaal, South Africa.
Reynolds, Dr. Dudley Sharpe, Louisville, Kentucky, U.S. America.
Rhead, Louis John, 72, Ocean-avenue, Flatbush, Long Island, U.S. America.

Richardson, Stuart, M.I.E.E., 117, Brougham-street, Wellington, New Zealand.
Siemens' Engineering Society, Telegraph Works, Woolwich, Kent.
Stephenson, James Keddie, The South African and Australasian Supply and Cold Storage Company, Limited, Dock-road, Cape Town, South Africa.
Sumitomo, K., Osaka, Japan.
Tabor, Robert Montague, Limpsfield, Surrey.
Talley, Thomas W., M.A., D.Sc., Tuskegee, Alabama, U.S. America.
Torbitt, William Stansfield, B.A., Municipal Technical School, Hull.
Toyama, Prof. Kametaro, care of Japanese Legation, Bangkok, Siam.
Von Nettelbladt, Baron, N.T.C.C.F.F.R., Keetmanshoop, German South West Africa.
Woodburn, J. Allan, care of Rezende, Limited, Suffolk-house, Cannon-street, E.C., and Umtali, Rhodesia, South Africa.
Woodhead, Samuel, 25, John-street, Bradford.
Yamamoto, Jotaro, The Mitsui Bussan Kaisha, Shanghai, China.

The CHAIRMAN said before proceeding with the ordinary business of the meeting, he felt sure they would be only echoing the feelings of every member of the Society present and absent, by passing a resolution expressing their thankfulness at the marvellous recovery of His Majesty. He thereupon moved the following resolution:—

"The Members of the Society of Arts, which for so many years has been deeply indebted to the fostering care of His Majesty the King, in his former capacity of President, and since his accession as Patron, being now in general meeting assembled, desire to give expression to their profound thankfulness at the merciful recovery of His Majesty from dangerous illness, as well as to their hope that His Majesty may long be spared to his loyal and devoted people."

The resolution was seconded by Mr. R. BRUDENELL CARTER, and carried unanimously.

The SECRETARY then read the following

REPORT OF COUNCIL.

I.—PRESIDENCY OF THE SOCIETY.

On the return of H.R.H. the Prince of Wales last autumn from his journey round the world, Sir Frederick Bramwell placed in the hands of the Council his resignation of the office of President, which he had held since the vacation of that office by His Majesty on his accession, and the Council immediately submitted to His Royal Highness on behalf of the Society, an expression of their hope that he would accept the office of President of the Society of Arts, which, as was mentioned in the last Report of the Council, was held since 1843 by H.R.H. the Prince Consort, and by His present Majesty as Prince of Wales.

In reply, His Royal Highness was graciously pleased to accept the office, and the Council, therefore, elected him until the Annual General Meeting. They have now, in accordance with the By-laws of the Society, placed His Royal Highness's name on the balloting sheet, being well assured that the general body of the members will approve and ratify their action.

II.—ORDINARY MEETINGS.

Sir William H. Preece, the Chairman of the Council, in the address with which he opened the 148th session of the Society, dealt with the scientific discoveries of the past century and their applications to practical purposes. Tracing the development of many of the inventions which have done so much for human progress, he showed their growth by evolution, and their direct connection with the great scientific principles first enunciated during the last hundred years.

At the first meeting after the one at which the Chairman's address was delivered, Dr. Gordon Parker, who has taken a very active share in the scientific work of the Bookbinding Leather Committee, gave an account of the work which had been done by the scientific members of the Committee, and on which work the Committee had based its report.

The following week Mr. Herbert Stone described the application of the microscope to the Identification of Timber. He pointed out the necessity which existed for a practical classification of timbers, referred to the inconvenience and loss caused by the absence of such a classification, and showed that the need might be supplied by the method which he had devised. A good deal later in the session, in April last, Mr. Edward T. Scammell read a paper also dealing with the supply of timber, a question which is now attracting a great deal of attention, and described "The Timber Resources of the Australian Commonwealth."

The development of the uses of aluminium and the methods employed in manufacturing that metal and its alloys formed the subject of a paper by Professor Ernest Wilson. At the last meeting before Christmas Professor George Forbes described a very ingenious range-finder which he has devised. The increased range of modern small-arms has rendered it necessary to obtain for military use some instrument which will enable the distance of an inaccessible and far removed object to be measured rapidly and with fair accuracy. With a base of moderate length there is of course no difficulty in doing this, and there already exist range-finders available for marine use, and also for the use of artillery, by which the required purpose is accurately attained. What is required is a portable instrument, capable of being used without any base, and not requiring any calculations. Such an instrument Professor Forbes claims to have obtained by the application of stereoscopic vision. In his instrument there is a vertical wire in each telescope. One of these wires is capable of being moved by a micrometer screw until the two wires appear as one; when the distant object is seen distinctly, the micrometer reading, showing the amount of adjustment which had been employed, gives the measurement of the distance.

At the first meeting after Christmas, Mr. Frank J. Gray gave an interesting account of the various devices which from time to time have been invented for the production of Ellipses, and showed that elliptical curves are practically used to a greater extent than would generally be supposed, so that the instruments used to describe them have more than a theoretical value.

In the year 1899 the Rev. J. M. Bacon read a paper before the Society on the use of "The Balloon as an Instrument of Scientific Research." His paper, read in January last, gave some account of the observations at high altitudes on which he has been engaged since he first devoted himself to this special investigation. A month later, Mr. Eric Stuart Bruce, the Honorary Secretary of the Aëronautical Society, described one use of the balloon which has attracted special attention of late—that is, its application for military purposes.

One branch of technical education—its application to paper-making—was treated by Mr. Clayton Beadle, who declared that the industry in which he was specially interested was one in which there existed a special need for technical education, but also one in which means for supplying that need were conspicuously absent. Later in the session—in the latter part of April—Professor Silvanus P. Thompson, to whom the Society is indebted for several important papers on the subject of technical education, added one more to the list in his paper on "Opto-technics," which was throughout a plea for the improvement of the technical education of those who are engaged in the optical industries.

The attention which has recently been directed to the development of the West Indian trade by the establishment of a new line of steamers from Bristol to Kingston in Jamaica, lent special interest to Mr. Herbert Thomas's paper on that island. The accounts given by Mr. Thomas of the efforts which are now being made to develop the fruit trade of Jamaica, and its other resources, were of much interest and practical importance.

The question of the overcrowding of the population of great cities, and the way of dealing with it, has been before the Society of Arts on various occasions, and several important papers upon it have been read. Mr. William L. Madgen submitted a new view of it in his paper on "Industrial Redistribution," and suggested, as a cure for the growing evil, the removal, as far as was possible, of industries from the cities into which they had now congregated to provincial centres, where they might be readily and economically established.

Professor Roberts Beaumont's paper on "Recent Inventions in Weaving Machinery" gave a clear and very intelligible account of the progress which has been made in the mechanical side of this important industry.

Twenty-two years ago, in 1880, Mr. E. Price-Edwards, of the Trinity House, gave an account of the experimeuts in sound signalling which had been carried out for the Trinity House by Professor Tyndall, then the scientific adviser to the Corporation. Mr. Price-Edwards this session brought the subject up to date in a second paper, in which he described the investigations which have been lately made by the Trinity House, and showed how great has been the advance in sound signalling during the period which has elapsed since the reading of his first paper.

Mr. John Hughes's paper on "The Utility of Alkaline Phosphatic Manures" was a useful contribution to a subject of great interest and importance to agriculturists.

There are few questions of greater importance to residents in London than the question of London transit. Mr. J. Clifton Robinson, in his paper on "Electric Traction," showed what has recently been done by the various applications of electricity to enable Londoners to move rapidly and easily about their great city, and indicated what in his opinion yet remained to be done.

Major-General Sir John F. Crease's paper on

"Ceuta and Gibraltar" was an able advocacy of the claims of the harbour of Ceuta on the other side of the Straits as a rival to the great fortress which England has so long held at the entrance to the Mediterranean. In General Crease's view, the superior advantages of Ceuta are great enough to justify the abandonment of Gibraltar.

Mr. J. Bridges Lee, in his paper on "Photographic Surveying," described the ingenious modifications of the photographic camera which he has introduced, with a view of making it available as an instrument for accurate surveying, and demonstrated its utility, not only for preliminary and incomplete surveys, but for making surveys of the utmost completeness and accuracy.

Mr. Albert Chancellor gave an interesting historical paper on "Carriages," and described a good many of the State carriages, a subject of some interest in connection with His Majesty's Coronation.

The last paper read during the session was by Mr. H. Warington Smyth on "Boat Building in the Malay Peninsula." Mr. Smyth is now engaged in the Mining Department of the Transvaal, and the paper had to be read in his absence; but Mr. W. W. Skeat, who had supplied a good deal of the information, was kind enough to correct the proofs and to revise the paper previous to publication. The paper was one of considerable interest to sailors, both professional and amateur, especially those who have devoted themselves to small boat sailing. It gave a very complete account of Malay craft, and was fully illustrated by original sketches of Mr. Smyth's, and by photographs from the collection of models of Malay boats now in the Cambridge Archæological Museum.

III.—Indian Section.

The work of this department of the Society continues to meet with much appreciation, especially in India, and perhaps no more valuable series of papers than that of the past year has been contributed to the Section since its formation in the sixties.

In view of the special interest at present attaching to India's intimate relationships with the neighbouring country of Persia, the Committee arranged for two papers bearing on the subject. One of these consisted of a graphic and picturesque description of the new trade route to Persia from our frontier to the Shah's dominions by Nushki and Seistan. The other dealt in a singularly able manner with Great Britain's connection with the Persian Gulf. The author of the former paper, Mr. Edward Penton, junior, traversed this new avenue of commerce in the winter of 1900-1, and his paper was the first complete account of the Nushki-Seistan route read before a London society. His object in making the journey was to ascertain exactly what the trading prospects are, and his investigations seem to show that the newly-opened route may have an appreciable effect in developing British trade in Eastern Persia. Sir Henry Drummond Wolff presided, and such well-known experts as Sir Thomas Holdich, Major Percy Molesworth Sykes, Sir Lepel Griffin, and Mr. H. F. Lynch, took part in the discussion. The paper on "The Past and Present Connection of England with the Persian Gulf" was contributed by Mr. T. J. Bennett, of *The Times of India.* After exhaustively setting forth the various stages in the evolution of the British status in that region, Mr. Bennett urged that his historical retrospect offers no encouragement to those who have lately urged that England should abdicate her position to the advantage of another Power; and concluded with some weighty remarks on the "Indian factor in the problem of the Persian Gulf." The educational value of Mr. Bennett's paper was pointed out by the Chairman, Sir Edward Sassoon, M.P., whose family had been for so many generations identified with the Persian Gulf.

The Society is to be congratulated on the fact that the Committee of the Indian Section were able to induce Mr. T. W. Holderness to prepare a paper on the Indian Famine of 1899, and the measures taken, under his able superintendence, to meet the wide-spread distress caused by the lamentable drought of that year. Mr. Holderness, in his valuable contribution, dealt mainly with Famine Relief, but he also referred to Famine Prevention, observing that the Indian administrator is between the Scylla of insufficient relief and the Charybdis of excessive profusion. He, however, feels convinced that the report of the recent Famine Commission will mark a great and permanent advance in famine administration. Sir Antony Patrick MacDonnell, the Chairman of that Commission, presided over the meeting, and in the course of a notable speech, maintained that before regeneration comes to India the stringency of its social problem must be mitigated. Later in the Session Mr. Holderness's paper was supplemented by a very interesting account from Mr. Preston, C.I.E., of that great engineering feat, the Chenab Canal, which irrigates an immense tract of previously arid land, known as the Rechna Doab. Until Mr. Preston read his paper few people in this country could have realised how much has been done to extend the benefits of irrigation in Upper India. Without reckoning the United Provinces, the Government channels to the end of 1900-1 extended to 16,345 miles.

Under the chairmanship of Lord George Hamilton, M.P., Professor Wyndham Dunstan, F.R.S., read an elaborate and comprehensive paper, in which he drew attention to the wealth which India possesses in her coal-fields and to the present position of Indian coal mining generally. He adverted to the quality of the coal mined and to the conditions under which mining is carried on in the different provinces; also insisting upon the importance of careful and sympathetic consideration being given by Government to the development of an industry hardly out of its infancy, but upon which the future of the industrial prosperity of India largely rests. The question of the general industrial development of India was treated in an interesting paper by Mr. Nilkanth B. Waglé. Mr. Waglé set himself the task of trying to turn to practical uses the "enormous enthusiasm" which he says is now growing up in India for the revival of old industries and the introduction of new. An important statement as to the measures about to be taken by the Government to advance technical education in India was made by the Chairman, Lord Hardwicke.

Under the title of "Bengal—its Land and its People," Mr. F. H. Skrine gave what he described as "a bird's-eye view of a tract nearly twice as large and populous as the United Kingdom"—the paper being admirable alike for its condensation, its literary merits, and the sympathy it showed with the people of the Lower Provinces. From Macaulay's days to our own the Bengali race, Mr. Skrine contends, has suffered much undeserved obloquy.

IV.—COLONIAL SECTION.

The Session was brilliantly opened with a paper entitled, "To the Victoria Nyanza by the Uganda Railway," contributed by Commander Whitehouse, R.N., whose survey of that portion of the great African lake under British jurisdiction has attracted the attention of geographers and travellers. After some four years' pioneering Commander Whitehouse describes the country between the sea coast and the Victoria Lake as anything but unpleasant, and mentions that stores of all kinds can now be obtained along the line at very reasonable rates. Of the many different tribes along the line, he speaks most highly of the Swahilis, familiar to passengers by Indian mail steamers as "seedy boys." Indeed, he declares that they are at present the most useful people in all Africa. Of the geographical facts narrated in the paper, Sir Harry Johnston, who took part in the discussion, spoke in the warmest terms, In short, he described Commander Whitehouse's survey of the lake as truly remarkable for the enormous additions made to our geographical knowledge. Sir Henry M. Stanley, who presided, mentioned that whilst it took Speke nine months and himself eight to reach Uganda from the coast, the journey can now be accomplished in two days and a half.

"The French Canadians and their Relations to the Crown" was the title of a valuable paper by a high official of the Dominion Government, Mr. W. T. R. Preston. Mr. Preston's object was to show that the descendants of those who, in 1608, founded New France, are not in any way "wanting in those attributes and characteristics which tend to make a great nation" —attributes and characteristics which ought to place them on a footing with English-speaking Canadians, "whose position," Mr. Preston thinks, "seems more thoroughly recognised in this country." Speaking from life-long experience, Mr. Preston maintains that, throughout the British Empire, there are no more loyal or trustworthy subjects of King Edward than the French Canadians.

The two remaining papers read before the Section referred to the Commonwealth of Australia. In one, the Hon. Sir John A. Cockburn, with his usual lucidity, expatiated on the sphere of State activity in Australia, and in the other, the Hon. H. W. Venn described the marvellous growth of Western Australia, which, in a little over two generations, has increased in population from 1,769 to 17,908, and in about the same time has raised its revenue from £13,000 to £3,078,034. Mr. Venn, in the course of his interesting paper, dwelt upon the solidarity and homogeneity of the Australian people as a factor in the problem of the future of those enterprising and progressive communities.

V.—APPLIED ART SECTION.

Six meetings were held during the Session in this Section. The first on January 21st was devoted to the consideration of "The Architect's Use of Enamelled Tiles." Mr. Halsey Ricardo discussed the use of tiles both for the outside and inside of buildings, and illustrated his subject by a large number of lantern slides of buildings in Europe and in the East. He strongly urged the use of colour decoration in our streets, and classed the purposes for which tiles are used in architecture under three headings—for hygienic purposes, for saving or reflecting light, and for decoration.

The second paper, on February 4, on "The History of the Rosary in all Countries," was read by the Rev. Herbert Thurston, S.J., at a meeting over which the Cardinal-Archbishop of Westminster presided. Father Thurston traced the use of the rosary in the East to the Hindoos long before the introduction of the Buddhist religion. Paternosterers or sellers of rosaries in Paris and London are mentioned in documents of the 13th century, and they probably existed long before that period. All the varieties of form in rosaries are to be found in the old sepulchral brasses, and the author showed how strong an influence the general use of the rosary in the Middle Ages had upon the art of the times.

Mr. Gerald C. Horsley read a paper on March 4 on "Structural Colour Decoration of the Interior of Public Buildings," in which he alluded to the growth of colour schemes intended to accentuate the architectural lines of large buildings. The author reviewed the various attempts at colour decoration in churches and other public buildings, and pointed out that there had been a decline in the decoration of our buildings in colour since the 16th century. He showed that there were two distinct modes of decoration, (1) in which colour was obtained from structural materials, as shown in floors, walls, and roofs, and (2) decoration in colour after the completion of the building.

At the fourth meeting, on April 8th, Professor Beresford Pite read a paper on "Street Architecture," in which he pointed out the difficulties attending the adaptation of rigid architectural rules to iron structures now so common in our streets. Uniformity and symmetry were still attainable, but he feared that picturesque streets were things of the past. The modern difficulty in the treatment of street architecture was the shop window, and the Chairman (Mr. Thomas G. Jackson, R.A.) agreed with Professor Pite that our commercial architecture must be frankly modern.

"The Printing and Illustration of the Modern Book" was the subject of Mr. Charles T. Jacobi's paper on May 6th. The author referred to what had been done in the past towards the production of a perfect book, and from what was to be learnt from this inquiry he deduced certain principles by adherence to which we might still hope to produce beautiful books. The work of the early printers was to be studied and followed with such adaptations as were necessary for modern requirements; thus, the best title pages of modern times were largely adapted from early Italian examples. The three elements in the production of an artistic book were type, paper, and ink. The illustrations should be in harmony with the type, but one of the artistic printer's greatest difficulties was that the paper best fitted for the type was often least fitted for adequate reproduction of half-tone prints.

The last paper of the session was read on May 27, by Miss May Morris, on "Pageantry and the Masque." In this scholarly paper Miss Morris gave a vivid picture of the pageants in the streets of London and other towns in the Middle Ages, and showed how artistically these shows were conceived and carried out, in striking contrast to the want of æsthetic fitness so manifest in much of the decoration of the present day.

VI.—CANTOR LECTURES.

The first course of Cantor Lectures for the present session was on the "Chemistry of Confectioners' Materials and Processes, and Chemical Valuation of Materials," by Mr. William Jago. Some years ago, in 1890, Mr. Jago delivered a course of Cantor Lectures on Bread-making, which has since been elaborated into a standard work on the subject. The present course was of a thoroughly practical nature, and the manufacture of cakes, biscuits, and sugar confectionery, was very fully illustrated, thanks to the kindness of Messrs. Peek, Frean and Co., Ltd., and Messrs. Clarke, Nickolls, and Coombs, Ltd., who lent the services of some of their skilled operatives for the purpose, so that the actual processes of manufacture could be carried on before the audience.

In the second course of lectures, Dr. Samuel Rideal dealt witth the subject of "The Purification and Sterilisation of Water." Commencing with the purification of water by natural agencies, the lecturer went on to the treatment of stored water on a large scale; while the last two lectures were devoted to filtration on a small scale, sterilisation, and chemical purification.

In the next course Mr. Cyril Davenport gave a historical account of "Personal Jewellery," well illustrated with the coloured lantern slides, in the production of which Mr. Davenport is known to be extremely skilful.

The "Application of Photography to Illustration and Printing" formed the subject of the fourth course, which was delivered by Mr. J. D. Geddes. Of the three lectures which formed the course, the first two were devoted to photomechanical processes and the various ways of producing printing surfaces for the production of pictures in black and white. The third lecture dealt with the three-colour printing process, by the application of which so large a proportion of the various coloured illustrations now popular is produced.

The last course of the session was by Dr. Richard T. Glazebrook on "Glass for Optical Instruments." Dr. Glazebrook gave an account of the very great improvements which have been made during the last few years in all optical instruments, in consequence of the resources placed at the disposal of the instrument maker by the various new glasses of high refractive power which have been introduced. After a general lecture on optical images, the nature of lenses and their faults, Dr. Glazebrook treated in succession the construction of the microscope objective, the photographic lens, and the telescopic objective.

VII.—Juvenile Lectures.

The Juvenile lectures this year were given by the Secretary of the Society, Sir Henry Trueman Wood, the subject being "Photography and its Applications." The first lecture dealt generally with elementary photographic optics, and described the formation of images by the lens, and the defects which had to be corrected before the lens was capable of producing accurate and satisfactory work. The applications of photography for scientific observation were illustrated by the exhibition of a large series of pictures illustrating the uses of photography in physics, astronomy, meteorology, microscopy, and many other branches of science. In the second lecture the actual production of the photographic picture was treated, and illustrations were given of the way in which the photographic image was retained and fixed. The second part of the lecture was devoted to the production of colour by photographic methods, and the principles of the three-colour process were demonstrated and described.

VIII.—Albert Medal.

The Council had great satisfaction in submitting to His Royal Highness the President for the award of the Albert Medal the name of Mr. Alexander Graham Bell, the Inventor of the Telephone, and the award was confirmed by His Royal Highness.

It is now just 25 years since Sir William Preece, the present Chairman of the Society's Council, brought over from America to Europe the first practical telephone, which was shown at the British Association Meeting in Plymouth in the year 1877. Since that date the telephone has of course been very greatly improved in its working, and its enormous development has led to many alterations in the original instrument used for transmitting speech; but the receiving portion of the instrument remains virtually in the same condition as when it was first practically introduced into this country. It will be remembered that in the original form constructed by Mr. Bell, the same instrument was used for receiving and transmitting, no battery whatever being employed. Other inventors, notably Mr. Edison, have enormously increased the power of the transmitter, by introducing the battery, and, thanks principally to the microphone of the late Professor D. E. Hughes, the instrument has gained its present perfection. No one, however, has yet succeeded in improving the articulation of the receiver, though many attempts have been made to increase the volume of sound emitted, and thereby to render more easily audible the messages which it receives.

Although Mr. Bell cannot claim to have been the first who transmitted articulate sounds by means of the electric current, he was certainly the first to make the invention of any practical utility, and his claim to rank as the inventor of the telephone has not been disputed.

The Council do not doubt that the Society generally will approve of the addition to the list of recipients of the Albert Medal of the name of the man to whom is due one of the most remarkable among the many wonderful inventions of the nineteenth century.

IX.—MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1901-1902:—

At the Ordinary Meetings:—

To J. GORDON PARKER, Ph.D., for his paper on "Leather for Bookbinding."

To HERBERT STONE, for his paper on "The Identification of Wood, and its Application to Scientific and Commercial Purposes."

To PROF. GEORGE FORBES, F.R.S., for his paper on "Range Finders."

To PROF. ROBERTS BEAUMONT, M.I.Mech.E., for his paper on "Recent Inventions in Weaving Machinery."

To E. PRICE-EDWARDS, for his paper on "Sound Signals."

To J. CLIFTON ROBINSON, Assoc.Inst.C.E., M.I.E.E., for his paper on "Electric Traction: London's Tubes, Trams and Trains."

To MAJOR-GENERAL SIR JOHN F. CREASE, K.C.B., for his paper on "Ceuta and Gibraltar."

To EDWARD T. SCAMMELL, for his paper on "The Timber Resources of the Australian Commonwealth."

To H. WARINGTON SMYTH, for his paper on "Boats and Boat Building in the Malay Peninsula."

In the Indian Section:—

To PROFESSOR WYNDHAM R. DUNSTAN, F.R.S., for his paper on "The Coal Resources of India."

To THOMAS WILLIAM HOLDERNESS, C.S.I., for his paper on "The Indian Famine of 1899, and the Measures Taken to Meet it."

To THOMAS JEWELL BENNETT, for his paper on "The Past and Present Connection of England with the Persian Gulf."

In the Colonial Section:—

To COMMANDER B. WHITEHOUSE, R.N., for his paper "To the Victoria Nyanza by the Uganda Railway."

To W. T. PRESTON, for his paper on "The French-Canadian Relationship to the Crown."

In the Applied Art Section:—

To HALSEY RICARDO, for his paper on "The Architect's Use of Enamelled Tiles."

To REV. HERBERT THURSTON, S.J., for his paper on "The History of the Rosary in all Countries."

On his resignation of the office of President, which, as before mentioned, Sir Frederick Bramwell had held during the interval that elapsed between the accession of His Majesty and the acceptance by H.R.H. the Prince of Wales of the Presidency, the Council presented Sir Frederick Bramwell with the Society's silver medal "in recognition of his services as President, Chairman, Vice-President, Treasurer, and Member of Council, 1875-1902." This medal was presented to Sir Frederick by the Chairman of Council, Sir William H. Preece, at the Council meeting of the 30th of June last.

X.—OWEN JONES PRIZES.

After the death, in 1874, of Owen Jones, a committee was formed to collect subscriptions for the purpose of founding a memorial. The money thus obtained was partly expended in erecting a monument over his grave in Kensal Green, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes have now been awarded annually since the year 1878. The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were awarded this Session, each prize consisting, in accordance with the regulations laid down for the administration of the Trust, of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates*:—

Hoare, Frederick, School of Art, Battersea. Design for a Printed Muslin.

Barber, George W., School of Art, Macclesfield. Design for Decorative Panels in Wall Tiles.

Gilchrist, Robert, Dalmarnock Art Class, Glasgow. Design for a Rug.

Kilpin, Jessie, School of Art, Leeds. Design for a Stained Oak Fire Screen.

Mason, George, School of Art, Bradford. Design for a Printed Silk.

Greenhalgh, Robert C., School of Art, Manchester. Design for Woven Hangings.

The next award will be made this summer, on the result of the present year's examinations. Six prizes have again been offered for competition.

XI.—PRIZES FOR DRAWING.

Since 1899, the Council have placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and, as usual, these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

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* This list has already been published in the *Journal*. See *Journal*, vol. xlix, p. 737, September 6, 1901.

XII.—Shaw Prize.

In January last the Council announced the offer, under the terms of the Benjamin Shaw Trust, of a Gold Medal, or a prize of £20, for improvements in industrial hygiene. The Medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors were asked to send in descriptions of their inventions not later than 1st May, 1902, to the Secretary of the Society of Arts, Adelphi, London, W.C. The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges nothing deserving the full award is sent in.

By the appointed date 43 applications had been received. These are now under the consideration of a Committee appointed by the Council, which it is hoped will be able to report before very long.

XIII.—North London Exhibition Trust.

In 1865 the Committee of the North London Working Classes and Industrial Exhibition (1864) presented to the Society of Arts a sum of £157, the balance of the surplus from that exhibition, with a view to the award annually of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society of Arts. The Art Workmanship Competitions were discontinued after 1870, and it has since been rather difficult to know how the funds arising from the Trust could be disposed of in a manner which might accord with the intention of the donors. In 1884 the Society offered certain prizes in connection with the Inventions Exhibition, and among these was one (a gold medal or £20) for the best set of specimens illustrating the handicraft teaching in any school. This was offered under the Trust in question, and was awarded to Mons. Germain on account of the collective exhibit from the Belgian Normal School for Women Teachers. In 1896 an amount of £22 odd was awarded in prizes at the East London Exhibition, held in that year. There is now a small accumulation of the interest on the invested capital, and the Council have decided that a very proper way of disposing of the available amount would be to offer it in art workmanship prizes for students connected with that part of the metropolis where the North London Exhibition was held. They, therefore, offered prizes amounting to £20 to the Committee of the Northampton Institute, Clerkenwell, and after a little correspondence a scheme has been agreed upon under which prizes amounting to fourteen guineas have been offered to students in the Art classes of that Institute. It is also arranged that a like amount shall be provided for next or for the succeeding year.

XIV.—Fothergill Prize.

Under this Trust the Council have offered a Fothergill Prize of £50 and a Silver Medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." It is suggested that the paper should consist of about eight to ten thousand words, and should be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

In 1896 a similar prize, offered for an essay or paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire," was awarded to Mr. Frederick Bathurst, Assoc.Inst.E.E., for a paper, which was read at a meeting of the Society on March 10, 1897.

The prize itself dates from 1821, £388 having been left by Dr. Fothergill to be awarded in medals or premiums for "promoting useful arts." Though the terms of the bequest are such as to leave the Council a very wide discretion in the award, yet, inasmuch as the testator suggested for consideration certain objects, all relating to the prevention of fire, the Council have thought it desirable that the prize should sometimes but not always be offered for purposes consonant with the suggestions put forward by the testator.

XV.—MULREADY PRIZE.

After the death of Mulready, in 1863, a fund was formed to establish a memorial to him. Sir Henry Cole was treasurer of this fund. The greater part of it was expended in erecting a monument over Mulready's grave in Kensal-green Cemetery. The balance, £109, was presented to the Society of Arts with the view of a Mulready Medal being presented occasionally to the student who should exhibit the best drawing from the nude at the annual examinations of the Education Department.

The Medal has been awarded on several occasions, the last occasion being in 1897. It is proposed to offer it again for competition amongst students of Schools of Art in the United Kingdom, at the annual competition to be held next year.

A gold medal, or a prize of £20, will therefore be offered to the student who obtains the highest awards in the following subjects:—

(*a*.) A finished drawing of imperial size from the nude living model.

(*b*.) A set of time studies on a small scale from the nude living model executed in a short time of varied shortly sustained poses.

(*c*.) A set of studies of hands and feet from the living model.

(*d*.) Drawing from the life including memory life drawing done at the Examination in 1903.

XVI.—EXAMINATIONS.

The examinations this year were held about a month later than usual, as it was thought that this would suit the convenience of the majority of the committees, and consequently it will not be possible to publish the results at the date at which they would have appeared had the examination been held in March as usual instead of in April. It is, however, hoped that they may be completed by the end of the current month.

The examinations for 1902 were carried out upon the same lines as those for 1901, in which year for the first time a preliminary grade was introduced. The increase in the number of candidates offering themselves for examination still continues. The number of entries this year was 11,058 in Grade II., and 5,286 in Grade I. The corresponding numbers last year were 10,612 and 4,966.

The precise number of candidates presenting themselves for examination in Grade II. cannot yet be given, but the number of papers worked was 9,968. The following Table, which deals with the numbers who actually came up for examination, shows the general results of the last ten years:—

Year.	No. of Candidates.	No. of Papers worked.	No. of Centres.	No of Subjects.
1893........	3,702	3,916	109	13
1894........	4,106	4,376	131	14
1895........	4,777	5,108	146	14
1896........	6,111	6,568	197	16
1897........	6,919	7,513	221	19
1898........	7,636	8,372	243	19
1899........	8,750	9,581	260	23
1900........	8,894	9,808	267	23
1901........	8,797	9,669	276	19
1902........	....	9,968	293	19

The standard for the first-class certificate was, in accordance with a resolution of the Examinations Committee, lowered from 75 per cent. of full marks to 70, and this makes it a little difficult to say how the standard of the candidates generally compares with that in former years. Last year the approximate percentages of first, second, and third classes were 11, 22·2, and 40·4, while the percentage of failures was 26·4. The percentages for this year are first-class 13·5, second-class 27, third-class 34, failures 25·5. Even allowing for the slight lowering of the standard for the first-class, it must certainly be admitted that these figures show a general improvement all round, an improvement which has now been manifested for the past three or four years.

As there were 9,968 papers worked this year as compared with 9,669 last year, there was an increase of 299. This increase is manifested principally in Book-keeping, 3,799 as against 3,676; Shorthand, 3,101 and 2,765; and Type-writing, 795 and 692. There are small increases in Arithmetic (222 and 216), Economics (54 and 33), Précis-writing (55 and 52), Italian (21 and 19). The other subjects all show a trifling decrease. In English last year the numbers were 201—this year 199; in Commercial Geography there were 119, and 114 this; in French 619 and 544; German 346 and 270; Spanish 193 and 170; Portuguese 38 and 33; Russian 9 and 7; and Danish 11 and 7. It cannot be looked upon but as a matter of regret that there should be even a small decrease in the number of students offering themselves for examination in modern languages, especially in such important languages as French and German.

Looking at the subjects a little more in detail, and considering the examiners' reports upon them, the general character of the examinations is distinctly satisfactory. In Book-keeping the percentage of passes is 81·61, a percentage which has risen gradually in the last four years from 68 in 1899; while the percentage of first-classes has gone up from 16·51 in 1901 to 20·53. The third-class and failures together this year amount to 42·92 per cent.; and the first and second-classes together to 57·08. In the examiner's opinion this indicates that the paper was a little easier than last year, although there is evidence of considerable improvement in the work of the candidates as compared with last year, which was itself a good one.

In Shorthand the number of first-class candidates is less than last year, but this fact the examiner attributes to the fact that the passage set for dictation was rather more than usually difficult. He also draws attention to the fact that a good many candidates enter who are not sufficiently qualified, so that nearly a third of the total number entering have failed.

In Type-writing there is a marked increase in the number of first classes, the percentages for this and last year being about 15 and 8; the percentage of failures is about 25 in each year.

In Arithmetic the general level of merit is reported as being higher than last year. The best of the candidates are extremely good.

As regards modern languages, the German examiner states that this year's work was of a higher order than last year, 92 out of 270 having obtained a first-class, whereas last year only 53 out of 346 obtained the same position.

The French examiner was able to award 83 first-class certificates out of 544 candidates, while 113 were not passed. Both the French and German examiners comment on the fact that many candidates enter for Grade II. who would do much better to present themselves for the preliminary examination in Grade I.

The examiner in Spanish speaks well of his results, and thinks the majority of the candidates show a good sound knowledge of the language.

The examiner in Portuguese is satisfied with the work done by the better class of candidates, though there were many who were really quite unprepared for such an examination.

The Italian examiner speaks well of the general character of the work sent in.

The examiner in English considers the average proficiency among the candidates generally is not high, though there are a few candidates whose work shows special merit.

The examiner in Commercial Geography is able to see a distinct improvement in the papers submitted this year.

In Précis-writing, the work done, except by a few of the best candidates, cannot be regarded as satisfactory, and it is to be regretted that more attention is not paid to this important subject. As the examiner remarks, the subject has special value as a test of intelligence.

It was mentioned in last year's Programme that a certificate of Proficiency in Commercial Knowledge would be awarded to any candidate who had passed in five specified subjects within a period of three years; but no applications for these certificates have yet been received.

The precise number of candidates for Grade I. cannot yet be stated, but the number of papers worked shows an increase on last year, when there were 4,458; in the present year there were 4,803.

The following table shows the number of candidates who passed or failed in each subject:—

Subjects.	No. of Papers Worked.	Passed.	Not Passed.
Handwriting.......	274	120	154
Shorthand.........	1,454	1,030	424
Book-keeping......	1,503	884	619
Commercial Arithmetic..........	276	183	93
Commercial History and Geography...	28	20	8
French............	607	331	276
German............	190	148	42
Type-writing.......	471	296	175
Totals......	4,803	3,012	1,791

This year, Book-keeping was the most popular subject, and it is also the subject which shows the largest increase, as there were 377 candidates more than last year. Shorthand, the next largest subject, shows an increase over last year of 293. In all the other subjects there is a slight falling off. In Type-writing 72 less candidates came up this year than last. In all the other subjects the differences are still smaller.

Six certificates in Elementary Commercial Knowledge were issued to candidates who had passed in the four specified subjects in 1901.

XVII.—VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

In November last the Examinations Committee made a recommendation to the Council that *vivâ voce* examinations in modern languages should be established by the Society. This recommendation was adopted by the Council, and the scheme subsequently prepared by the Examinations Committee was approved.

It is obvious that such examinations cannot be held simultaneously at a number of different centres in the manner in which the Society's ordinary examinations are held, and it was therefore necessary to prepare a special scheme for the purpose. It was decided, in the first instance, that the examinations should be held in French, German, and Spanish, with an intention of adding other languages as the demand might arise. It was announced that an examination would be held at any date, at any of the Society's examination centres, where the local committee undertook to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate for not less than 24 candidates.

It was believed that this fee would almost cover the necessary charges, and it was expected that the Society would make a small loss on each examination. This expectation has, in fact, been realised; but the amount which the Society has been called upon to pay has been trifling, and inasmuch as a small profit has for the last year or two been made on the examinations, even this loss does not actually fall upon the Society's general funds. In addition to this fee, the Local Committee is expected to pay the examiner's travelling expenses, where any are incurred.

The examination was arranged to include dictation, reading, and conversation. It was understood that the test was intended to apply merely to proficiency in colloquial French, German, or Spanish. The candidates, therefore, were to gain a certificate if they could express themselves fluently in the language selected. It was stated that minor grammatical errors would not prevent success.

Up to the present the following examinations have been or are being held:—

At the Birkbeck Institution, London—French.

At the Manchester School Board—French, German, and Spanish.

At centres under the London School Board (Hungerford-road, St. Pancras, and Thornhill-road, Barnsbury)—French.

At the Merchant Venturers' Technical College, Bristol—French and German.*

At a centre organised by the Technical Education Board of the London County Council—French German and Spanish.

The Council regard the experiment as decidedly successful, and they anticipate that in future years the numbers will largely increase, and that these examinations will form an important element of the Society's general system. In all cases the Examiners speak highly of the candidates who have presented themselves, and they have been able to maintain a decidedly high standard. It is believed no candidate has been awarded a certificate who does not possess a knowledge of the foreign language such as would render him of considerable use in any business occupation in the country in question. Naturally, a number of persons thoroughly familiar with a foreign language have availed themselves of the opportunity to obtain a certificate in it; and a certain proportion of the candidates have shown an idiomatic knowledge of the language in which they were examined, such as would be expected from a well educated native of that country.

XVIII.—PRACTICAL EXAMINATIONS IN MUSIC, 1901.

The Practical Examinations in Music for 1901 were not concluded last year until the 6th July, too late for the results to be included in the last Report of the Council. They were, however, published in the *Journal*.† The examination lasted for 11 days, and was conducted by Mr. Ernest Walker, M.A., Mus.Doc. Oxon., and Mr. Burnham Horner.

The system of examination was the same as that which has now been in force since 1896. For instrumental music certain standards are given, and candidates are asked to select for themselves in which of these standards they choose to be examined. The standards range from easy to very difficult music. For each standard a list of music is given for study, and for the pianoforte examination a selection from this list is sent to the candidates six weeks previous to the examination. For other instruments the pieces can be chosen at once from the general list. Candidates are then expected to play or sing the pieces which they have prepared, and in the third and fourth standards to play a piece, or a portion of a piece, at sight, in addition.

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* Results not yet known.

† See *Journal*, vol. xlix, p. 641, July 12, 1901.

In all, 566 candidates entered, and of these 551 were examined, an increase of 5 as compared with the previous year; 5 of these took up two subjects, so that there were 556 examinations. Of these there were 476 passes and 80 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, mandolin, guitar, and organ. 413 entered for the piano, 352 of whom passed and 3 obtained medals; 89 entered for the violin, of whom 81 passed; 5 entered for the violoncello, 4 of whom passed; 3 passed for the mandolin; 6 entered and 5 passed for the organ, and 1 obtained a medal; 39 entered for singing, of whom 30 passed, 2 obtaining medals; 1 entered for the guitar and passed.

Some statistical information about these examinations since their establishment in 1879, will be found in the last Report of the Council.*

XIX.—PRACTICAL EXAMINATIONS IN MUSIC, 1902.

The Practical Examinations for the present year have not yet been concluded. They only commenced on Tuesday, July 1st, the date this year being a little later than usual on account of the date fixed for the Coronation. They will be finished on July 12th, after which a summary of the results will be given in the *Journal*. The work of the examination is being carried out by the same examiners as in the last two years; 415 candidates have entered for the present examinations.

XX.—EXHIBITION OF ENGRAVING AND ETCHING.

In the year 1899, an exhibition of lithography was held by the Science and Art Department, at the instance of the Council of the Society. This exhibition, intended in the first instance to commemorate the invention of lithography by Aloys Senefelder in 1798, proved extremely popular, and was very successful.

In the following year the Council suggested to the Department (now the Board of Education) that an exhibition should be held to illustrate the progress which had been made during the past forty years in the typographical reproduction of drawings for book illustration. This exhibition also proved attractive and instructive.

The Council of the Society recently suggested that the series should be completed by the holding of an exhibition, which should include the various methods of illustration which have not been dealt with in the previous exhibitions held by the Department, viz., engraving, photogravure, and the various photographic processes other than those applicable to typographic work. In the opinion of the advisory committee, to which this proposal was referred, it was of too wide a scope for it to be adequately treated in a single exhibition, and they therefore recommended the Board of Education to confine the next exhibition to engraving and etching alone, and to defer to a later period the holding of an exhibition which might illustrate the various applications of photography other than typographical.

The Board adopted this modification of the original suggestion, and have now announced that they will hold, during the early part of next year, an Exhibition of Engraving and Etching, in the Victoria and Albert Museum, South Kensington. The Exhibition will consist of examples of copper and steel engraving, including line, mezzotint and stipple (plain and coloured), aquatint and etching.

The date for the exhibition has not yet been announced, but it is understood that it will be in the early part of 1903.

XXI.—MEMORIAL TABLETS.

It was mentioned in the last Report of the Council that arrangements had been made for erecting a tablet to Milton in Bunhill-row. The house itself, and, indeed, all the original buildings in Artillery-row, have long since disappeared; but the site of the house has been identified within very narrow limits, and it is certain that that site is now covered by the factory of Messrs. Le Grand and Sutcliffe, on the buildings of which, by permission of the firm, the tablet has been put up.

In October last, the Council received a letter from the London County Council, in which it was stated that the Historical Records and Buildings Committee of the Council proposed to advise the Council that they should undertake the work of indicating houses and localities of interest in London. Before taking action in the matter, the Committee wished to know what the Society's views on the point might be, and expressed a desire to be assisted by their co-operation. The Council thereupon resolved that the Society of Arts would co-operate with the London County Council, and a letter was addressed to them, expressing the satisfaction with which the Council of the Society had learned that the County Council proposed to undertake the work, and offering any assistance which the Society could render.

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* See *Journal*, vol. xlix., p. 612, July 28th, 1901

The Society has since been in correspondence with the County Council, and hope that the work which was initiated by the Society as far back as 1868, and has since been carried on by them, may now be continued on a larger scale than is possible in the case of a private Society.

XXII.—SOANE MUSEUM.

Under the Act by which the affairs of the Soane Museum are regulated, the Society of Arts have to nominate a trustee. The office is held for five years, and the last election having been in 1897, it is necessary that the Society should exercise their power during the present year. The Council recommend for election Sir George Birdwood, who has acted for the previous five years, and whose services the Council are assured have been much appreciated by the Governing Body of the Museum.

In 1833 Sir John Soane presented to the nation the house which he had built in Lincoln's-inn-fields, and in which he had placed his very valuable collections of pictures and objects of antiquarian interest together with his extensive library. At the same time he obtained an Act of Parliament by which the property was vested in Trustees—four appointed by himself, and five by the Corporation of London, the Royal Academy, the Royal Society, the Society of Antiquaries, and the Society of Arts—the four original nominated Trustees having the power to fill up by election vacancies in their number as they occurred. The authority of all the Trustees is the same, but the property is vested in the Life Trustees, and they only have the power of signing cheques. Sir John Soane also provided the funds necessary for the maintenance of the house as a Museum. He died on the 20th of January, 1837, and shortly afterwards the Museum was placed under the authority of the Trustees.

The following is a list of the Trustees appointed by the Society of Arts:—

1837 to 1843—H.R.H. the Duke of Sussex, President of the Society.
1844 to 1857—H.R.H. the Prince Consort, President of the Society.
1857 to 1864—Sir Charles Wentworth Dilke, Bart.
1865 to 1876—Samuel Redgrave.
1876 to 1882—Alan S. Cole, C.B.
1882 to 1896—Sir Benjamin Ward Richardson, M.D., F.R.S.
1897 to 1902—Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

XXIII.—NEW COUNCIL.

The balloting list bears for the first time the name of His Royal Highness the Prince of Wales as President of the Society.

The four senior Vice-Presidents retiring are Lord Belhaven and Stenton, Sir John Evans, Sir Charles Malcolm Kennedy, and Sir Thomas Sutherland, all of whom were elected Vice-Presidents in 1898. Sir William White, who has been a Vice-President since 1899, also retires. His Royal Highness has exercised his power under the bye-laws by nominating for election H.R.H. the Duke of Connaught, the Duke of Abercorn, and Sir Frederick Bramwell. For the vacancies above mentioned, the Council propose the names of Sir Frederick Abel, Major-General Sir Owen Tudor Burne, Professor James Dewar, Sir Walter Prideaux, and Sir William Roberts-Austen, all of whom have at different times served on the Council.

As usual, four ordinary members of Council retire by seniority or by least attendance. They are: Sir Robert Giffen, Sir Walter Prideaux, Sir William Roberts-Austen, and Mr. Carmichael Thomas. In their place the Council propose the names of Sir Mancherjee Merwanjee Bhownaggree, Sir Alexander Binnie, Sir George Livesey, and Sir Westby Perceval. Of these four, only the last-named —Sir Westby Perceval—has been on the Council in previous years.

The nomination of Sir Owen Tudor Burne as a Vice-President, leaves a vacancy as Treasurer. To fill this the Council propose the name of Mr. Carmichael Thomas.

XXIV.—PORTRAIT OF THE SECRETARY.

A number of present and past members of the Council subscribed to present to the Secretary, Sir Henry Trueman Wood, a portrait of himself, painted by Professor Hubert von Herkomer, R.A., as a reminiscence of his long connection with the Society, which has lasted since the year 1872, his secretaryship dating since 1879.

The portrait, which at the present time is being exhibited at the Royal Academy, was presented to Sir Henry at a dinner given by the Chairman of Council, Sir William Preece, to the members of Council, and the other subscribers to the portrait.

XXV.—OBITUARY.

The Society has lost during the past twelve months many well-known members, amongst whom were several active contributors to its work, and several also who were frequent attendants at its meetings.

Sir John Donnelly (*Journal*, 11 April, 1902) joined the Society more than forty years ago, in 1860; ten years later, in 1870, he became a member of the Council, and since that date he took a prominent part in its work, occupying the post of Chairman in 1894-1895.

Another member of the Council of almost as old standing as Sir John Donnelly was Sir Villiers Lister (*Journal*, 7 March, 1902), who had been a member of the Society since 1863. His first appearance on the Council was in 1883.

General Cotton (*Journal*, 18 October, 1901) was Chairman of the Council in 1877. Though of recent years his great age prevented his taking an active part in the labours of the Society, he continued until a short time before his death to maintain a great interest in its proceedings.

Mr. G. F. Wilson (*Journal*, 4 April, 1902) was one of the oldest members of the Society, having been elected as far back as 1845. He served on the Council in various capacities from 1854 to 1857.

Sir Henry Gilbert (*Journal*, 3 January, 1902), to whom the Albert Medal was awarded in 1893, joined the Society as far back as 1855.

Admiral Selwyn (*Journal*, 17 January, 1902) was another member of old standing, who had been elected in 1864. He presided on several occasions at the Society's meetings, and was a frequent contributor to its discussions.

Sir Charles Bernard (*Journal*, 27 September, 1901), the distinguished Indian civilian, was a valued member of the Committee of the Indian Section.

Mr. J. K. Starley (*Journal*, 8 November, 1901), the inventor of the safety bicycle, read a paper on the "Evolution of the Cycle" in 1898.

Mr. Matthew Gray (*Journal*, 3 January, 1902), for many years managing director of the India-rubber, Gutta-percha and Telegraph Works Company, of Silvertown, was a member of the Society since 1876.

Sir James Chance (*Journal*, 10 January, 1902), the head of the firm of Chance Brothers and Co., was well-known for the important improvements in lighthouse illuminating apparatus effected by his firm under his personal co-operation and direction.

John Brett, A.R.A. (*Journal*, 10 January, 1902), the distinguished painter, was a frequent attendant at the Society's meetings, though he took no part in the discussions.

Mr. Horace Seymour, the Deputy-Master of the Mint (*Journal*, 4 July, 1902), was elected a member of the Society two years ago.

Other members of the Society who have passed away during the year are Sir Conrad Reeves (*Journal*, 7 February, 1902), late Chief Justice of Barbados, Lord Malcolm (*Journal*, 14 March, 1902), Sir Sidney Shippard (*Journal*, 4 April, 1902), formerly Administrator of Bechuanaland, Dr. William Miller Ord (*Journal*, 30 May, 1902), Sir James Richey (*Journal*, 4 July, 1902), Mr. Ivison Macadam (*Journal*, 4 July, 1902), and Colonel N. L. Walford, R.A. (*Journal*, 8 November, 1901).

Biographical notices of the above and of other members of the Society deceased, have appeared in the *Journal*.

Baron Nordenskiöld (*Journal*, 30 August, 1901), the celebrated geographer, was a honorary member of the Society, and Professor Cornu (*Journal*, 9 May, 1902), the distinguished physicist, was a honorary corresponding member.

Mr. John Farmer (*Journal*, 26 July, 1901), who acted as musical examiner to the Society for the years 1895 to to 1899, and retired in 1900 in consequence of ill-health, died during the past year.

XXVI.—FINANCE.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

Among the receipts of the year is included a legacy of £50 left to the Society under the will of the late Mr. W. Anthony Herring. Mr. Herring, who died in January, 1901, was elected a member of the Society in 1870.

The CHAIRMAN moved the adoption of the Report.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., in seconding the motion, deprecated discussion, and asked whether the time allowed for the ballot could not be shortened.

The CHAIRMAN said it was customary to invite members to discuss the Report, so that they might have an opportunity of finding fault with the Council, if they considered the Council had not done their duty; or of raising questions dealing with the improvement of the work of the Society; or of bringing before the Society anything that may have occurred during the year. As regards the time allowed for the ballot, the By-laws were rigid on that point—that the ballot must remain open for one hour.

SIR GEORGE BIRDWOOD thanked the members for the complimentary terms in which his services as Soane Museum Trustee had been referred to, and said he felt undeserving of them. His work in connection with the Museum had always been very agreeable, and there were many pleasant features connected with it. Another point he wished to refer to was the Secretary's course of Juvenile lectures on "Photography and its Applications." It was one of the most instructive and pleasant courses of Juvenile lectures delivered before the Society.

Surgeon Lieut.-Colonel J. INCE thought the discussion of the Report gave members the opportunity of showing that they appreciated the manner in which the Report had been drawn up. He supported the motion that the Report be adopted.

Mr. W. MARTIN WOOD, in referring to Sir George Birdwood's remarks, said that the Annual General Meeting was the only opportunity the members had of expressing their opinions with regard to the management of the Society. He reminded them of what he had pointed out in former years about holding the Annual General Meeting in the evening instead of the afternoon, and said that he felt sure if the meeting were held in the evening there would be a much larger attendance and it would attract more interest. He thought the By-laws on this point could be altered if the Council desired it. Another suggestion that he had to make was that the Conversazione might be held with greater advantage later in the year, shortly before the opening of the Society's session in November. He also suggested on the proposition of one of the oldest members of the Society, that the Society should hold provincial meetings, and take up that part of the work of the Social Science Conferences which was most congenial to the Society, and which was not dealt with by the British Association. If the Society could see its way to hold Conferences in the provinces on these lines, he ventured to think that it would be conducive to the Society's interests, would enlarge the scope of its work and attract attention to its objects, besides adding valuable contributions to its records, and increa ing the number of members of the Society. He pointe out that no mention was made in the Report this ye of the expiration of the lease of the Society's hous Offices and buildings suitably situated were muc needed for its expanding usefulness and work, and h suggested that there was a grand opening for th beneficence of the members.

The CHAIRMAN thanked Lieut.-Colonel Ince an Mr. Martin Wood for their remarks. Taking th last point raised by Mr. Martin Wood, he said tha the question of the Society's house was one that wa occupying the attention of a committee of the Societ very closely indeed. He hoped that next sessio they might be in a position to make some definit report as to what was likely to be done for the benefi of the Society. The present rooms were scarcel large enough, and he had no doubt that the Society's work would be very much extended if they were housed in larger and better premises. Mr. Woo had suggested that the Annual General Meeting should be altered from the afternoon to the evening, but he (Sir William Preece) was of opinion that By-laws were not very easy things to alter. However, serious attention would be given to Mr. Martin Wood's proposal. Referring to the recent Conversazione, he said it was one of the most pleasant functions of the season. As regards extending the scope of the Society's work, he thought he ought to point out to Mr. Martin Wood that there was no limit to the subjects of the papers which might be read before the Society. The Council were quite prepared to accept papers dealing with Social Science subjects. He considered there was no reason why they should not accept papers on questions of Social Science, but that there was a very good reason why they should look with some hesitation on meetings in the provinces. He was of opinion that meetings in the provinces had been too frequent of late. There was scarcely any question which was not made the subject of a meeting in the provinces, and the result was that the inhabitants of the provincial cities had been bored with a succession of these meetings, for which hospitality is demanded, and guarantees required. On that ground alone, he was inclined to object to such a proposal.

The adoption of the report was then agreed to.

The CHAIRMAN moved a cordial vote of thanks to Sir Henry Trueman Wood (the Secretary), Mr. H. B. Wheatley (the Assistant Secretary), and the other officers of the Society, which was seconded by the Hon. RICHARD CLERE PARSONS, and carried unanimously.

The SECRETARY, in returning thanks for this expression of confidence in himself and in the other officers of the Society, referred to the honour the present and past members of the Council had done him by presenting him with his portrait.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Connaught and Strathearn, K.G.
Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.Sc., D.C.L., F.R.S.
Duke of Abercorn, K.G., C.B.
Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S.
The Lord Chief Justice, G.C.M.G.
Lord Avebury, D.C.L., F.R.S.
Sir Benjamin Baker, K.C.M.G., F.R.S.
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Sir Edward Birkbeck, Bart.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
Michael Carteighe, F.C.S.
Professor James Dewar, LL.D., F.R.S.
Sir Edwin Durning-Lawrence, Bart., M.P.
Hon. Sir Charles W. Fremantle, K.C.B.
Henry Graham Harris
Ludwig Mond, Ph.D., F.R.S.
Hon. Richard Clere Parsons
Sir Walter S. Prideaux
Sir William Chandler Roberts-Austen, K.C.B. F.R.S.
Lord Rothschild
Sir John Wolfe-Barry, K.C.B., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Sir Mancherjee Merwanjee Bhownaggree, K.C.I.E., M.P.
Sir Alexander R. Binnie
R. Brudenell-Carter, F.R.C.S.
Professor Francis Elgar, LL.D., F.R.S.
Robert Kaye Gray
Sir William Lee-Warner, K.C.S.I.
Sir George T. Livesey
Sir Walter Peace, K.C.M.G.
Sir Westby B. Perceval, K.C.M.G.
Sir William Henry Preece, K.C.B., F.R.S.
Alexander Siemens
Sir John I. Thornycroft, F.R.S.

TREASURERS.

Sir Owen Roberts, M.A., D.C.L., F.S.A.
Carmichael Thomas

SECRETARY.

Sir Henry Trueman Wood, M.A.

SOANE TRUSTEE.

Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.

On the motion of the CHAIRMAN, a vote of thanks to the scrutineers was carried unanimously.

The Hon. Sir CHARLES FREMANTLE, K.C.B., proposed a vote of thanks to the Chairman, the motion was seconded by Surgeon Lieut.-Colonel J. INCE, and carried unanimously.

Miscellaneous.

THE KAIPING COALMINES.

The following particulars are taken from a paper by Herbert C. Hoover, read before the Institution of Mining and Metallurgy, and printed in the *Colliery Guardian*:—

These coalmines, the first successful mines in China, are of considerable interest in that they are the pioneers in mining under the peculiar conditions of China, and will afford in an economic sense no little interest in the mining and industrial world.

Location.—The Kaiping coalfield is located near the Gulf of Pechihle in Chihle Province. The field extends for twenty-three miles along the Tientsin-Neuchwang Railway, and the centre of the field is sixty-two miles by rail from the port of Tongku, and seventy-three miles by rail from the new port of Ching Wan Tow. The proprietors own a canal reaching within seven miles of the mines, affording, in addition, water transport to seaboard at Tongku, and connecting with the interior canal system of China.

History.—The company was founded in 1878 by Tong King Sing, and through the Viceroy, Li Hung Chang, the right was secured to open mines by foreign methods. In 1879 a pit was opened at Tongshan, and in 1889 a second pit was opened at Linse, and in 1894 a third was opened at Hseshan. In 1880 the company constructed a canal from Hsu Ko Chwang, a village seven miles from Tongshan, to Lutai, a distance of about fifteen miles, thus securing connection with the waterways of the interior. In 1885 the first railway in China was built surreptitiously by the foreign *employés* of the company, first to connect with the head of the canal. It was at first operated with mules, but later an engine was built, and upon the inhabitants becoming accustomed to that, it was extended to seaboard at Tongku, and was taken in hand by the Imperial Government and developed in the Imperial Northern Railway system. In 1900 the company was transformed into an English company—the Chinese Engineering and Mining Company, Limited—the coalmining rights expanded to cover the entire coalfield, and foreign administration introduced. The proprietors have large shipping and wharf interests on the China coast, and are improving the harbour of Ching Wan Tow with seawall, and modern appliances for handling coal, gaining thereby freedom from the winter closure by ice of the harbour at Tongku, and a depth of water rendering possible much deeper draught colliers.

The coal production has been:—

	Tongshan and Hse Shan.		Linse.	
From 1881 to 1897 inclusive	4,312,409	..	730,000	
From 1881 to 1898	469,921	..	262,000	
,, ,, ,, 1899	528,240	..	250,000	approximately.
Total	5,310,570		1,242,000	

Geology.—A peninsular-shaped range of sub carboniferous limestone hills stretches out from the larger ranges in the north of the province, dying out at Tongshan into the great alluvial plain. This promontory forms, roughly, the axis of a sharp anticlinal fold, and the coal measures dip away sharply to the north and south. The two parallel coal basins thus formed are, except for their outcrop along the flanks of this single line of hills, practically buried by the alluvial. The northern outcrop of the southern basin is traceable for a distance of about twenty-three miles, turning at the "spoon" of the basin east of Linse, and then traceable for a distance of six or seven miles eastward, disappearing under the alluvial. The outcrop of the northern basin is evident in only two places, so closely does the alluvial lie upon the hill sides. The structure of the western or Tongshan end of the field is greatly disturbed by faults, one of the largest cutting the Tongshan mine off from the rest of the field by a throw of several thousand feet. Eastward of this fault there is little faulting, and the coal has an average dip south of about 45 degrees along the whole northern side of the southern basin. For the distance that the outcrop can be traced on the south side of the basin, the dip is about 30 degrees north. The average section shows about 800 feet of shales and slates overlying the limestones, and made up partly of fire-clays. Upon this there rest the productive coal measures, consisting of sandstones, slate, and coal, to a thickness of about 800 feet.

Coalseams.—The number and thickness of the seams vary greatly at different points in the field. There are seventeen seams known, but none under 2 ft. 6 in. are considered workable, and of workable seams there are from six to eight. Complete sections of the measures are known at Tongshan, Ma Chia Kou, Wu Shui Chwang, points about equidistant along the north rim of the southern basin, and they show an average of about 85 feet of workable coal. At Linse, on the east end and southern rim of the southern basin, the coal has thinned somewhat, and gives but 60 feet.

Character of the Coal.—The coal is bituminous. It varies greatly in analyses with different seams and localities. It burns with a long flame, is easily melted, produces a strong, massive, yet porous coke. The best quality seams compare favourably with average English and American bituminous coal, and are superior to any bituminous coals known in the East. All of the coal possesses the disadvantage of softness, and the second and third qualities contain a generally high per-centage of ash. However, softness is not a great disadvantage, for the Chinese generally demand slack coal. By washing, the percentage of ash can be so reduced as to yield an excellent metallurgical coke. It is used for gas manufacture in the Treaty Ports, and is also used for domestic purposes; but, like all fatty coals, it possesses the disadvantage of an excess of soot. For commercial purposes the coal is divided into three classes, "navy," "locomotive," and "household."

Coking Qualities.—At present considerable coke is made from uncleaned dust and in primitive native ovens. The best quality of this coke, the percentage of phosphorus and sulphur, is well within admissible limits, but the percentage of ash is high. The coke furnished the Han Yang Ironworks is stated by their engineers to be superior to all Asiatic cokes furnished, and gave an average of ash 12 per cent., sulphur ·82, phosphorus ·05. This coke was made, as said, in very primitive ovens and without cleaning.

Quantity of Coal Available in the Field.—The average of estimates by various engineers called in at the time of the recent transfer of the company gives above a distance of 2,000 feet vertically, a recoverable amount of coal of about 400,000,000 tons, or a supply not likely to be in demand over the Asiatic coast or on the Pacific for some years to come.

Cost of Mining.—Workmen's wages are very low—coolies 5d. to 7½d. per day, native miners 6d. to 10d. per day, skilled mechanics 2s. to 3s. per diem. Double-tracked roadways cost, including bricks, masonry, &c., about 6s. to 10s. per foot. The simply appalling and universal dishonesty of the working classes, the racial slowness and much lower average of intelligence gives them an efficiency far below the workmen of England and America. For crude labour, such as surface excavation, he has no equal, but as we proceed up the scale of skill, he falls further behind, until when we arrive at the skilled mechanic and factory operative, the productive cost with Chinese labour are as great per unit of production as in England and America. In two years these mines, with the management now installed, will prove the economic advantage of the cheapest value in the world, and will be of no mean interest from an industrial standpoint.

Market.—A matter of no little interest to coal miners in China is the peculiar character of the market. Growing out of the fact that the coal production of China hitherto has been coal procurable above water level, and therefore somewhat decomposed, the Chinese have grown to the use of slack coal. Their stoves and kilns are constructed therefor, and, where lumps are demanded, briquettes are made with clay-binding, and preferred to lump, so that the native market is for slack coal, and that regardless of percentage of ash. Though the Kaiping mines have produced since the beginning over 3,000,000 tons of slack, there are no culm piles—but all has been sold to the native market. The price at present for slack is 8s. per ton at pit's mouth, and lump 16s. This company is preparing for an output of 2,000,000 tons per annum, a portion of which will be exported to Western America.

THE WINE INDUSTRY OF QUEENSLAND.

The introduction into Queensland of the *Vitis vinifera* dates back about fifty years. It was in the early forties that young vines or cuttings were brought up from New South Wales and planted about Brisbane. The varieties introduced appear to have been well selected, as amongst them were the Black Hermitage, Pineau, Gouais or Burger, and Sweetwater. Prizes for three wines were taken by a Queensland exhibitor at the London Exhibition in 1862. It was at a later period, towards the end of the sixties, that a number of cuttings of American varieties, such as the Isabella, Concord, Goethe, &c., were brought over from the United States by sailing ships, which quickly ousted many of the European grapes by reason of their superior disease resistant powers. The Isabella in particular found especial favour, and is now met with in all parts of the State. Ipswich was one of the first places in Queensland to cultivate vines to any extent, and from there this branch of the agricultural business spread to Toowoomba and the intermediate districts. Every variety of soil favourable to viticulture is to be met with in Queensland—granitic, volcanic, calcareous, sandy, alluvial, &c. In every district is found one or more of the above soils, but at the same time there is a large area of flat country with clay subsoil which is discarded for viticulture. According to the Queensland official Year Book there is a mistaken impression abroad that Queensland is unable to produce good wine, but this is not the case, as that State could produce in the south-eastern district as good wines as the bulk of that made in other parts of Australia if more care were shown in the choice of grapes, the treatment of the must during fermentation, and the subsequent manipulation of the young wines. Until a year or two ago there was not a single Carbenet or Malbec vine in the country for making wine of the Bordeaux type; the grapes used being principally the Mataro, Black Spanish, Lenoir, and some Black Hermitage. Now their value is being recognised, and they are being more extensively planted. There is a better choice of white grapes in Queensland, the White Hermitage, Sauvignon, Vert, Mauzac, and Clairette being fairly abundant; but there is room for other varieties, especially for the production of sherry types. Some Spanish and Portuguese varieties have lately been introduced into the State for propagation and distribution with a view to improving the port and sherry types made. Generally speaking, the light white wines made in Queensland are of better quality than the light red, many of the latter being coarse, heavy and astringent, whereas some very creditable wines of the Chablis class are made round Roma. In some cases the light wines are ruined by the addition of preservatives to keep them sound; the vitality of the wines is paralysed by the action of these antiseptics, and no improvement or maturity of the wine can take place until the preservatives are removed by chemical decomposition; if, when that takes place, a second dose is added, the conditions continue, and the wine remains in a permanent state of rawness. With a judicious blend of Carbenet, Malbec, and Black Hermitage, and a few acid white grapes, such as the Folle or Burger, and with attention to the must acidity, temperature of fermentation vat, and duration of vatting, Queensland, it is said, could produce as good wines of the Bordeaux type as any of the Southern States. Some effervescing wines of the Champagne type are produced, which, considering the difficulty of producing this class of wine, reflect, it is said, credit on the makers, but they have a tendency to heaviness and sweetness. The quantity of wine made in Queensland, in 1900, was 132,489 gallons, a considerable decrease on former production —for in 1897, for example, 207,745 gallons were produced. The falling off is attributed either to bad seasons and failure of crop, or to more grapes being sold for eating purposes than formerly, as the acreage under vines in 1896 and 1900 was practically the same.

FRUIT GROWING IN JAPAN.

Fruit growing has not hitherto been an important industry in Japan, and, when attempted, it has been as a side occupation of the farmer or gardener, there being a few farms in which fruit forms the staple crop. Fruits originally cultivated, and probably native in Japan, include the orange, pear, peach, sour plum, almond, grape, persimmon, loquat, pomegranate, gingko or salisburia. and fig. The "suykan," or Japanese sweet orange, is smaller, sweeter, and less juicy than the oranges grown in the United States; and the thin membrane separating the sections of the fruit is tougher. It is cultivated all through the warmer regions of Japan, and is the most plentiful of the fruits grown there, being found in the markets from early autumn until late in the following spring. The country also produces an orange larger and more acid than the Californian product, and sometimes bitter. According to Consul-General Bellows, of Yokohama, it is not much valued, and is produced in small quantities only. The persimmon comes next to the orange in the number produced, and is a favourite with the natives, but its season is comparatively short. The sour plum is extensively cultivated, and yields a good crop, but the other fruits named above, though more or less widely grown, are produced in much smaller quantities—the fig being most abundant, and most valued of the less important fruits. The Japanese Government has introduced peaches, pears, and grapes from Europe and America, and has found the soil and climate well adapted to their production, so that these are now cultivated in addition to the native varieties of the same fruits. Of the fruits wholly unknown in Japan, until introduced from abroad, the apple has proved the most successful, and it has become a chief product of some districts in the Kokkaido, or northern islands. The apples are of fine appearance and excellent flavour, and the trees yield a profit very encouraging to the cultivator, so that the area of their production is being increased. Cherries have also been introduced; but although the fruit is inferior, it is hoped that the greater skill in cultivation which will come from longer experience may yet produce very satisfactory results. The native cherry tree produces a profusion of beautiful flowers but no fruit, and the Japanese gardeners have cultivated it solely with reference to these, having developed a variety with clusters of large double blossoms. Strawberries and other small fruits are raised by gardeners in the vicinity of the large cities, and the plants bear fruit of fine appearance but little flavour. The natives eat fruit chiefly fresh, and its use as a table diet is not general, although it is increasing. The process of drying and canning fruits is beginning to come into use, but only as a means of preserving the fruit for home consumption, not for export. Dried raisins, apricots, figs, and prunes are imported in small quantities, but it is stated by dealers that the goods are sold only to foreign residents and to ships taking in supplies for a voyage. During the moist, hot summer, flour, meal, dried fruit, and all similar merchandise, quickly becomes infested with maggots unless securely protected, and it is therefore necessary that the fruit should be put up in bottles, tin cases, or closely sealed boxes before it is shipped.

SOCIETY OF ARTS' CONVERSAZIONE.

The Queen newspaper contained the following notice of the Society's *soirée*:—"It would hardly be possible to imagine anything prettier than the Society of Arts' *conversazione* in the gardens of the Royal Botanic Society on Tuesday evening, June 24th, when the chairman, Sir William Preece, K.C.B., F.R.S., and the other members of the Council, received a very large number of guests at the entrance to the conservatory, near the broad walk. The guests seemed transported to fairyland, the trees all covered with luminous fruit, all the pathways outlined with lamps, and the central gravel walk bordered on either side by uprights, with five or six Chinese lanterns on each. On the front of the conservatory was the Royal crown and 'E.R.' illuminated. 'God save the King' was in every heart. The lighting by Kitson's incandescent oil light shed a soft glow on the trees of these pretty gardens, and the whole effect was ght and luminous. The night was all that could be desired. Refreshments were to be had in the *caj* attached to the clubhouse and in marquees on th east lawn all the evening at comfortable little tables where the guests sat and evidently enjoyed themselve in the beautiful summer night. It is seldom that a *al fresco* entertainment is a perfect success as far a weather is concerned, the exception in this cas proved the rule. The conservatory and the clubhous were both thrown open, and in the former the strin band of the Royal Artillery gave a delightful concer all the evening, and a selection of music was performed by the band of the Scots Guards on the wes lawn, and the Red Hungarian Band on the east law and in the clubhouse. The programme of each o these were well chosen, Cavalier L. Zavertal, M.V.O. R.A., conducting the string band of the Royal Artillery, Mr. Fred W. Wood the band of H.M. Scot Guards, and Herr Gyula Hegedüs the Red Hungaria Band. It was delightful to hear the favourite melodie of the hour floating on the night air. In addition t these attractions there was a tent with a specia collection of growing plants and cut roses, shown i a marquee on the west lawn by Messrs. William Pau and Son, of Waltham-cross, and the exhibition o rhododendrons by Messrs. Waterer, of Bagshot, wa seen under a most charming aspect lighted up in th huge tent, where the delicate shades of mauve an red mingled with white recalled some beautiful woodland scenes across the Atlantic. The men were al in evening attire, and so were many of the ladies some of them even then wearing hats; but th majority were certainly in morning dress. It was a ideal night for such an entertainment, but deep anxiety was in every heart on account of the King."

General Notes.

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Austrian Exhibition.—The Exhibition of Austrian Fine Art and Decorative Furnishing at Prince's Skating Club, Knightsbridge, which was opened on the 26th May by the Austrian Ambassador and the Lord Mayor of London, will close on the 31st inst.

Aeronautical Society.—Meeting, Thursday, July 17, at the Society of Arts, John-street, Adelphi, 8 p.m. Papers will be read on the "Peace" Balloon of the late Senhor Augusto Severo—(1.) By Dr. Carlos Sampaio; (2.) By Mr. Eric Stuart Bruce, M.A. "Balloon Ascents in Thunderstorms," by the Rev. J. B. Bacon (with Lantern Illustrations). Note on "A Performance of the Bristol War Balloon during the South African War," by Captain H. B. Jones, R.E. Note on the "Cycala Flying Machine," by Dr. Charles Zimmerman.

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FRIDAY, JULY 18, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

Since the notice which appeared in the *Journal* of May 9th, the following *vivâ voce* examinations have been held:—

Subject.	Place of Examination.	Date.	No. of Candidates.	Passed.	Failed.
German	Manchester School Board...	5 May	14	9	5
French...	Hungerford-road School, N.(London School Board)	27 May	20	15	5
"	Birkbeck Institution (Examination arranged by Technical Education Board of the London County Council)............	17 & 18 June	56	42	14
Spanish	Do. do.	19 June	11	8	3
German	Do. do.	20 June	17	12	5
French...	Offord-road School, N. (London School Board).	7 July	30	22	8
"	Merchant Venturers' Technical College, Bristol ...	9 July	19	13	6
German	Do. do.	10 July	23	8	15
	Totals	....	190	129	61

The examiners were Monsieur Naftel for French, Professor H. G. Atkins, M.A., for German, and Professor Ramirez for Spanish.

The total number of candidates examined his year is 280, of whom 202 have passed and 8 have failed.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill Prize of £50 and a Silver Medal for paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper hould consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges no paper deserving the full award is sent in.

Proceedings of the Society.

CANTOR LECTURES.

THE PURIFICATION AND STERILISATION OF WATER.

By Dr. Rideal, F.I.C.

Lecture I.—Delivered January 13, 1902.

Purification by Uncontrolled Natural Agencies.

Water absolutely pure can only be obtained with great cost and care by laboratory processes, and even then it is difficult to preserve in a state of purity, as it dissolves many of the gaseous and solid substances with which it comes in contact. For ordinary purposes it is sufficient that the impurities present should not be poisonous, or cause disease, or be otherwise objectionable.

The physical or "organoleptic" characters of a water are by no means a safe guide to its wholesomeness. Brightness may be due to a filtration through a porous soil which is quite inadequate to remove danger, a sparkling quality to dissolved gases produced by decomposition of organic matter, and a brisk taste to nitrates and chlorides of animal origin. Yet water from shallow wells in towns has frequently been preferred by residents to a purer public supply, and considerable opposition is often encountered to the closing of such sources. On the other hand, many flat, insipid, and even cloudy waters have caused no injury in use, their faults having been due to causes which had no hygienic importance. Yet it is obvious that a potable water should be agreeable to the senses, hence it will be of advantage, before dealing with the removal of dangerous pollutions, to briefly review those physical characters of colour, transparency, odour, and taste, which in some cases give important information as to its previous history.

Transparency or turbidity is measured by the length of column through which an object can be seen when gradually lowered from the top, and afterwards approached from the bottom, the mean being taken as the measurement. Laboratory samples are usually only classed as turbid, very turbid, nearly clear, or clear. On the large scale various "diaphanometers" have been employed. Secchi, in 1865, used in the Mediterranean a white disc, 20 centimetres in diameter; later, by the Geneva Commission, an incandescent lamp was lowered, noting the limits of "clear vision" and of "diffused light." This method is specially adapted for wells. Sensitised photographic plates have also been used, but colour considerably interferes with their record. For smaller quantities of liquid, Hazen, at Lawrence, Mass., attached a bright platinum wire, one millimetre in diameter, at right-angles to the end of a graduated rod, recording the turbidity in degrees; invisibility at one inch being taken as unity; other degrees were fractional, inversely as the depth at which the wire was obscured. If the turbidity was more than one, the sample was proportionally diluted; if less than 0·22 (50 in.), the turbidity was ascertained in another water, and this diluted to imitate the sample as nearly as possible. The jars or bottles were cased in black cloth and illuminated from below ("Filtration of Water Supplies," by Allen Hazen, Wiley, New York, 1900). Whipple and Jackson* have introduced silica standards for turbidity, made by finely grinding the silicious frustules of diatoms, suspending in water, and diluting to definite volumes. These standards seem to have many advantages over those obtained by means of kaolin or chemical precipitates.

Waters which appear limpid to the eye may yet contain an appreciable amount of solid matter in suspension, consisting of substances and organisms so transparent that their presence can only be proved by filtration. Comparison should always be made with a pure water.

If a bright transparent natural water be examined in a dark room with a ray of sun or electric light, the course of the ray will be traced by the very fine suspended particles, which no sand or ordinary filter is capable of removing, while they are arrested by hardened filter papers or by good candle filters. Sir E. Frankland (Water Examiners' Report, Jan. 1898) states that the amount of this matter in the efficiently filtered river water supplied to London rarely, if ever, exceeds ·0046 parts per 100,000, which he considered negligible. Dibdin (London County Council report, 1896) found it to vary from ·0014 to ·0080, averaging ·0040, containing 53 per cent. of mineral and 47 per cent. of volatile and organic matter, the latter containing 2 to 3 per cent. of its weight of nitrogen. In country districts the water from wells is often very turbid when drawn, but becomes clear when allowed to stand for a short time. In many cases the solid particles in depositing effect a considerable bacterial improvement, as we shall notice further under sedimentation.

Colour is observed by looking at an illuminated white surface through a two-feet column of the water contained in a horizontal cylinder closed by glass plates; also with less distinctness through a column in a vertical jar. For ordinary purposes a thin tumbler of the water may be set on a sheet of white paper in a good light. Pure water has naturally a blue tint. A greenish tinge is communicated by algæ, a brown by peaty and sometimes by animal matter, and a red tint is often due to iron. Various colours may be also communicated by manufactures.

Many conventional standards have been proposed for obtaining figures of comparison between waters by means of coloured solutions on the same principle as Nesslerising. Formerly, as the yellow and brown tints were considered the most important, the Nessler test alone was used, recording the results in amounts of ammonia required to produce the same colour. The method, however, had many faults. Crookes and Dewar, for their reports to the London Water Companies, employed two hollow glass wedges, containing the one a solution of copper sulphate for the blue tint, the other a mixture of cobalt sulphate and potassic dichromate for the brown, sliding over one another in front of a circular hole. The figures are stated in millimetres thick of blue and brown, and are recorded in the official report of the Local Government Board.

Hazen employs standard mixtures of solutions of platinum and cobalt, the unit of colour being one of platinum in 10,000 of water

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* *Eng. Record*, N. Y., Jan. 27th, 1900.

(*American Chemical Journal*, xiv., 300). The London County Council measure the colours in terms of red, blue, and yellow, by comparing the sample with an equal column of distilled water, before which graduated coloured glasses are interposed in Lovibond's Tintometer.

Taste, though often deceptive as to composition, is of great importance from the consumer's point of view. Some of the London official reports speak of an "evanescent smoky taste." This, though certainly possible in a smoky town, does not seem to be elsewhere recorded. But tastes and odours due to minute algæ and animal* growths in reservoirs and pipes have frequently occasioned serious trouble, while earthy and vegetable or marshy flavours are sometimes communicated by larger aquatic plants, and mouldy tastes and smells by fungi. Custom may render such waters comparatively innocuous, but nausea, diarrhœa, and other ill effects have been traced to their use. Waters astringent from tannin, acid or alkaline from chemicals, brackish from sodium chloride, bitter from magnesium salts, inky from ferrous compounds, or sulphuretted or sulphurous, are readily appreciated by taste, and are obviously unsuited for ordinary drinking.

Odour is often a valuable indication. It may be earthy from clay, peaty from upland sources, marshy from rivers, swamps and ponds, sulphuretted, or even urinous from recent sewage contamination. The odour is best observed by half-filling a stoppered bottle with the water, warming to about 100° Fahr., shaking vigorously with the stopper slightly loosened to relieve the pressure of the gas, and smelling carefully, preferably in comparison with a pure water warmed to the same degree. The natural odour of pure warmed water is very slight.

In special cases a large volume of water may be extracted with pure ether, or a litre distilled and the first portions collected. Distillates from all waters have a "boiled" odour, due probably to an alteration of the organic matter by the heat; in pollution with sewage a peculiar camphoraceous smell is often observed, due to a neutral substance which I have isolated from sewage distillates in white volatile crystals. No exact measurement of odour has yet been attained, and the nomenclature has no precision. A fishy taste and odour, due probably to trimethylamine, attends some bacteria of putrefaction which may invade water, such as *B. fluorescens putridus*; others, such as *Bacterium sulphureum*, and Beyerinck's class Aerobacter, generate sulphuretted hydrogen. Apart from the smell produced by decay, some odours affecting large bodies of water are due to oils secreted by algæ and protozoa. Anabaena, Scenedesmus, and Asterionella among the algæ, and some *flagellate infusoria*, such as Uroglaena and Synura, have given great annoyance from this cause. Several public water supplies in England have at times been suddenly invaded by fishy odours and tastes attributed to Volvox, Nostoc, and other organisms. At Cheltenham, in 1891, the fault was traced to Chara foetida or some of its parasites. The fishy odours are generally produced by animal, the aromatic by vegetable organisms. It is found that these difficulties are avoided by adopting covered or dark reservoirs. Boiling the water in many cases removes the odour.

In some parts of Essex, according to Thresh, the water derived from veins of sand beneath the boulder clay has a faint but decided odour of sulphuretted hydrogen when first drawn, but the smell entirely disappears upon leaving the water exposed to the air for a short time in a bucket or tank. He adds that "In these districts, however, the inhabitants will drink any kind of ditch or pond water rather than this."

Temperature should always be observed at the time of taking the sample. The preference for deep supplies depends to a certain extent on their coolness, but in mains laid near the surface this advantage rapidly disappears. The importance of temperature is seen in the considerations that—

1. Great fluctuations indicate imperfect protection, or variability in the source, with possible extraneous pollution.
2. At a higher temperature the growth of bacteria, especially pathogenic organisms, is encouraged.
3. When used for cooling purposes, every degree of rise marks less efficiency.
4. The amount of oxygen and other gases capable of being dissolved is less as the temperature becomes higher.

This leads us to the question of *Aeration*, which is often an important point in the purification of water, as many processes, notably that of boiling, deprive the liquid of its natural gases and render it flat and insipid. Water to be palatable should be well aerated, *i.e.*, it should contain fairly full amounts of the natural constituents of the atmosphere, oxygen, nitrogen, and carbonic acid, otherwise it tastes flat and insipid. Dissolved oxygen is necessary for fish life, and also for the self-purification of rivers, since it is also required by the bacteria which oxidise the organic impurities they contain. River water on boiling gives off about one-twentieth of its bulk of a mixture of oxygen, nitrogen, and carbonic acid. Water can dissolve under ordinary conditions about its own volume of carbonic acid, 3 per cent. of oxygen, and $1\frac{1}{4}$ per cent. of nitrogen, when in the presence of each gas singly. In contact with the air each gas is absorbed in proportion to its coefficient of solubility and to its gaseous tension, so that the amount is greatly lowered by a rise of temperature. Since air contains about one-fifth of its volume of oxygen, and four-fifths of nitrogen, the relative tensions of each gas will be one-fifth and four-fifths. Then the amounts dissolved from air will be approximately 3 per cent. by $\frac{1}{5} = 0·6$ per cent. for oxygen, and $1\frac{1}{2}$ by $\frac{4}{5} = 1·2$ per cent. for nitrogen. In practice about 7 c.c. of oxygen, and 14 c.c. of nitrogen are contained in a litre of water at an average temperature. A deficiency of oxygen in a natural water, is a suspicious sign, usually indicative of fermenting organic matter, consequently the determination of free dissolved oxygen is often of great value. (See Rideal and Stewart, *Analyst*, June, 1901, and Rideal, Aeration Test, *ibid*, August, 1901.) In some deep well waters, however, which have been almost out of contact with air, the process of natural purification will have augmented the free nitrogen, the dissolved oxygen almost disappearing.

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* A "bitter and cucumber taste" in the Boston (Mass.) water supply caused trouble in 1881 and 1892. It was traced to the protozoon Synura. (Whipple.)

Rain, which is natural distilled water, should theoretically be pure, were it not that it carries down with it a number of the floating impurities of the air, and also dissolves from the latter its gases and varying amounts of ammonia, nitrate and nitrite, besides in towns sulphuric acid from the burning of coal, and near the sea chlorides of sodium and magnesium from the salt spray. After a time, when the atmosphere has been washed, the rain becomes much purer even in towns. In its collection from the roofs of houses, a rain-water separator should be used, in the form of a tilting bucket, which diverts the first portions down a waste gutter, and then does not recover its position while the rain is falling, but allows the subsequent purer part to pass into a cistern. In many places storage cisterns are built underground; it is absolutely essential that they should be cemented watertight to prevent pollution from the surrounding soil. In the course of the inlet pipe should be an easily accessible strainer. The average amount of rain that could be collected from roofs is estimated at from $2\frac{1}{2}$ to 3 gallons per day for each person, so that it generally requires to be supplemented by other water. Some years ago I devised an arrangement by which the strained rain water was collected at a higher level in the house cistern and made up to the volume required per day by means of the ordinary town water admitted by a ball-cock. An economy in the supply, besides a reduction in the aggregate hardness was thus effected. The portion required for drinking and cooking should be sterilised by a Pasteur-Chamberland filter or other means.

NATURAL PURIFICATION.

Besides atmospheric distillation, we know that water is also naturally purified by sedimentation in rivers and lakes, by percolation through porous soils and rocks, and by bacterial action originating chemical processes of resolution and oxidation. It is important to distinguish between the latter actions, because they are often confused together as effects of simple oxidation.

When organic matter undergoes decay the change is usually accompanied by the formation in small quantity of complex substances of higher colour. It has been clearly proved that polluted waters when deprived of bacteria absorb little or no oxygen from sterilised air, and remain practically unchanged.

The first resolution of complex organic molecules is due to hydrolysis, which splits them up into two or more simpler groups. The transformation is naturally caused by bacteria or enzymes produced by them. It is usually not until after this change has been accomplished that the bacteria concerned in oxidation produce carbonic acid, water, and nitrogen or nitrates. For this reason it is wrong, as is frequently done, to call the process simply a combustion or oxidation, since this ignores many intermediate reactions; it is also wrong to consider it purely from a chemical aspect, as biological action plays a necessary part.

That portion of the rain which sinks into the soil undergoes a natural filtration obviously varying in efficiency according to the fineness of the porous strata and the depth to which it penetrates, and is conveniently classed as shallow, subsoil or ground, and deep or artesian water. The first variety accumulates in gravels near the surface, and though easy to procure is dangerous, and should be condemned for drinking, being merely the surface water scarcely improved. Yet in the extension of London in former times, early maps show that the population followed the porous strata or beds of gravel, and at first avoided a clay soil, not so much on account of dampness, as because the water was difficult to reach. In inhabited districts, the shallow water is often a mere solution of the sewage that has soaked into the soil from the numerous privies and cesspools, and has been proved in many cases to have transmitted disease rapidly over a neighbourhood, besides permanently establishing a lower standard of health. Such water must be carefully excluded from deep wells and from purified supplies. An example from my own analysis of two wells in the same district is instructive :—

PARTS PER 100,000.

	Solids.	Cl.	Free NH_3.	Albd.	Nitrogen as Nitrate	Nitrite.	
Well 93 ft. deep, sub-soil sand ...	30·0	1·9	·003	·0067	·568	trace	Clear, colourless, inodorous.
Shallow well in gravel...	290·3	27·2	·002	·0274	·070	heavy	No odour, sediment contained fungus spores and mycelium & infusoria.

The rapid penetration of bacteria through the more porous soils was demonstrated in direct experiment by E. Pfuhl (Zeits. f. Hyg., 1897, 547), who showed that certain organisms could traverse in one hour 26 feet of gravel, and that a shallow well soon became contaminated with *B. prodigiosus* when cultures were poured into the surface at 12 feet horizontal distance from the top.

In sinking further into the ground, percolation through porous strata affects changes in several ways :—

1. Solid particles are removed and the liquid becomes clear. Occasionally, however, a turbidity is again caused by the diffusion of particles of clay or chalk ; the latter difficulty has given rise to much complaint recently at Enfield, and is an example of a water chemically and bacterially good, not being at once acceptable for drinking. Subsidence, or simple filtration, remedies the objection.

2. The particles of soil also exert to some extent an absorptive or mordant action on dissolved organic matters. In the case of strata containing iron or manganese, the hydrated metallic oxides may make this very considerable, and it may be followed by a certain amount of chemical action from the action of the oxides as carriers of oxygen. But in ordinary soils this effect is slight and soon exhausted by even moderately polluted waters. There has been a tendency to exaggerate the mechanical action on dissolved matter in percolation.

3. Soluble matters are added to the water by the beds through which it passes ; by dissolving lime and magnesia it becomes hard ; it may even be rendered unpotable through saline, ferruginous, or bituminous strata. Some of these faults may be remedied by softening processes, which we shall consider later, but many spring waters, although they have undergone a second purification in their ascent and are organically pure, cannot be used for drinking on account of their mineral contents.

4. Solid organic substances detained mechanically in the upper layers are liquefied by bacteria, and will for the time increase the dissolved organic matter, and subsequently, as a consequence, the amount of dissolved carbonic acid and nitrogen is increased and the oxygen diminished.

5. Finally, the organisms are reduced in number and eventually removed. It has long been recognised that in compact soils, at six feet from the surface, few organisms are found. On the other hand, porous polluted soils may contribute pathogenic organisms to waters derived from wells even of considerable depth.

NATURAL PURIFICATION OF SURFACE WATERS.

Natural purification of surface waters takes place in a variety of ways. In lakes and slow-moving bodies of water, sedimentation plays an important part. The water in entering them is often turbid, but in leaving is clear and bright, as in the well-known case of the Lake of Geneva. Fol and Dunant found 150,000 bacteria per c.c. near the shore, and only 38 in the middle of the lake. In Loch Lintrathen, which supplies Dundee, P. Frankland (*Proc. Roy. Soc.*, 1893, liii., 225) found in the inflowing burns 1,700 and 780 germs per c.c.; in the outlet of the loch only 30. The natural purification of rivers has been a much debated point, the late Dr. Tidy contending that water containing 20 per cent. of sewage became purified by oxidation in a flow of 10 to 12 miles, while Sir E. Frankland considered that 200 miles would not be sufficient, and it has even been affirmed that "no river on earth is long enough to purify itself after being once organically polluted." These statements were mostly made before biological action was understood. On the Continent, the self-purification of a number of rivers has been determined bacterially and chemically, notably the Isar, Spree, Limmat, and Danube, and found to be very considerable, but to vary greatly under different circumstances. In America, independent observations on canals and rivers in Michigan and Illinois proved that sewage pollution disappeared in a flow of less than 50 miles. With conditions that are favourable the purifying action of rivers is known to be very great. In some cases towns on the banks of rivers of considerable width and having a fairly constant volume and velocity during all seasons, have discharged raw sewage into the stream for many years, yet investigation has shown that not many miles below there was little or no trace of the contamination.

The rate at which suspended solids settle depends on the rapidity of flow, on the nature and state of division of the solids, and on the temperature. But if sedimentation occurs to too great an extent it fills up the river-bed or causes foul banks to form. When the suspended organic matters are deposited, practically beyond air and light, they are attacked by anaerobic bacteria in the river bed, dissolved, and made available for the ordinary water-bacteria in the river, which break them up still further until they are finally oxidised, the nitrifying organisms playing an important part. Dr. Delépine (*Journ. of State Medicine*, Aug., 1901) finds as the result of his experiments that the purifying effects of sedimentation are most manifest "when the flow of the water is rapid enough to prevent the accumulation at any point of the products of bacterial multiplication, but not so rapid as to interfere with a comparatively rapid action of gravity." Also that "agitation of water—as opposed to continuous flowing motion—by disturbing the sediment containing the bacteria which have become thrown out of suspension, interferes with the purification of water by sedimentation" In other respects Meltzer found in 1894 that moderate agitation is rather favourable to bacterial action and promotes cell-division.

Dr. P. Frankland (third report, Roy. Soc., 1894, 516), also found that moderate agitation with intervals of rest on the whole promotes the growth of bacteria.

According to a commonly observed phenomenon, the bacteria, after a great multiplication on account of pollution, having done a great part of their work, rapidly decline in numbers. P. Frankland gives an example of this diminution in flow for even short distances in his examination of the River Dee for 40 miles. Above Braemar the river showed 88 bacteria per c.c.; after receiving Braemar sewage, 2,829; some miles further down, 1,139; after access of fresh sewage, 3,780; some miles lower, 938; another addition of sewage, 1,860; further down, 950 (*Proc. Inst. Civ. Engineers*, Nov., 1896). Another instance given in a report by Dr. Reynolds, of Chicago (*Eng. Record*, N.Y., March 16th, 1901), on the Desplaines and Illinois rivers:—

Collecting Stations.	Miles.	Chlorine parts per 100,000	Colonies of bacteria per c.c.	Number of determinations.
Bridgeport (sewage of Chicago)	0	11·9	1,215,000	19
Lockport	29	11·7	650,000	30
Joliet	33	10·5	486,000	28
Morris	57	6·8	439,000	26
Ottawa	81	5·8	27,400	26
La Salle	95	4·6	16 300	31
Henry	123	4·4	11,200	29
Averyville ..	159	4·1	3,660	30
Wesley City..	165	4·1	758,000	22
Pekin	175	3·8	492,600	29
Havana	199	3·6	16,800	26
Beardstown ...	231	2·9	14.000	26
Kempsville ...	288	2·3	4,800	19
Grafton	318	1·8	10,200	28

The number of determinations is an important matter; conclusions based on isolated experiments have much less value. The samples in this case were collected weekly during eight months. A series carried out on a smaller section of 24 miles with a current of only half a mile per hour shows:—

Station.	Distance. Miles.	Time. Hrs.	Colonies per c.c. in mid stream.	Percentage removal of Organisms.
Morris......	—	—	204,000	—
Seneca	12	24	49,000	76
Ottawa	24	48	10,700	95

The inference drawn is that during the flow of 24 miles the river became nearly free from the great mass of sewage bacteria with which it was originally laden, "and that the bacterial contents of the Illinois at Ottawa were not greatly in excess of that of the local tributary streams."

The Thames above the intakes of the London water companies contains an average of 10 to 20 thousand bacteria per c.c. In November, 1901, I found 9,500 at Westminster.

The English, Continental, and American results concur in showing—

1. That river water in its raw state is quite unfit for drinking.

2. That after passing populous centres, although the natural purification effects a great improvement, it still leaves a large number of bacteria, including many pathogenic forms. In the preceding Table it will be noticed that, after a flow of 159 miles, the number of organisms was still 3,660 per c.c.; in the second case (Wesley to Kempsville), after 123 miles, it was 4,800; in Frankland's case, on the Dee, the lowest was 950.

3. Therefore, that the objection to what are termed biological effluents, that some bacteria pass the filters and contaminate the river, is counterbalanced by the facts that (*a*) the river water contains the organisms already, (*b*) that proper bacterial effluents tend to be better than the river, (*c*) that if water for drinking must be drawn from the river, further purification is always necessary.

The reduction in the number of sewage organisms in streams has been attributed to—

1. Mechanical agitation and aeration. We have seen that the former may be even favourable to bacteria, and the improvement effected by these agencies as occurring in cascades and weirs is certainly less than was formerly believed. This also holds with regard to the chemical composition. The water below Niagara Falls, according to Dr. Leeds, shows no decrease of the free ammonia or of the oxygen consumed, and only a small reduction in albuminoid ammonia (*Journal Amer. Chem. Soc.*, Nov. 1890).

2. Dilution by underground springs will diminish the number, that by tributaries may increase or diminish it according to the character of the effluent. The amount of dilution can be judged by the chlorine figures in relation to the volumes. Thus, in the preceding Table, the dilution shown by the chlorine figures is far less than the bacterial reduction.

3. Action of sunlight. Buchner, by immersing cultures of bacteria to different depths in a lake near Munich, showed that the bactericidal action of sunlight did not extend in clear water to a greater depth than 9 feet; in turbid rivers it would hardly penetrate more than a few inches. In actual experiments, little or no difference is noticed in the diminution of the numbers on bright and on cloudy days.

4. Action of larger organisms, or "plankton," either by consuming the food supply or by actually feeding on the bacteria. This effect would be very variable.

5. Exhaustion of the food supply by the bacteria themselves, and elaboration by them of products inimical to their own growth, are undoubtedly active causes of their disappearance; but the one that is most conducive is certainly:—

6. Sedimentation, of which more will be said in our next lecture.

Rivers rapid in flow, or liable to frequent floods, and carrying in suspension large quantities of mud, silt, or clay, are a very undesirable source of supply, as the amount and wide variations in the size and character of these impurities makes their removal difficult and expensive. Examples are more common in other countries than in England. In the Ohio River, for instance (Cincinnati Report, 1899), the following figures were observed:—

Number of days in the year.	Suspended matter; parts per 100,000.
41	1·1 to 5·0
63	5·1 to 10·0
127	10·0 to 25·0
99	25·1 to 50·0
29	50·1 to 100·
5	100·1 to 200·
1	over 200
	Average 23.

The time required for subsidence is not in proportion to the amount of suspended matter, since the finer clay brought down in later periods of flood takes longer to settle than the coarser matter of the first rush. As for example from the same report:—

Hours settling.	Suspended solids. Parts per 100,000.		Per cent. deposited.	
	First rush.	Later.	First rush.	Later.
0	233·3	20·5	0	0
1	93·2	8·1	60	55
3	65·3	8·0	72	56
6	39·6	7·9	83	56
12	35·0	7·3	85·0	58·0
24	30·0	6·1	87·0	63·0
48	25·9	4·4	89·0	67
72	21·0	3·6	91·0	70·0
96	18·6	3·1	92	72

This shows also the very long time often required for the clearing of the first storm water, and the necessity for its being excluded from an intake.

On these experiments Mr. Fuller observes :—

> "From a sanitary standpoint, the large proportion of suspended organic and vegetable matter during the greater part of the year must be considered to be objectionable, although in no very marked degree. In fact, it is in the lower stages of the river, when the water is comparatively clear, that its hygienic character is the least satisfactory. The practical significance of these facts is, that when the river is high and the water is muddy, the water is not dangerous, although it is not free from suspicion for drinking purposes. When the river is low and the water is clear, its healthfulness is always questionable, and the degree of danger involved depends chiefly upon the prevalence of disease in cities higher up the valley. As population in the watershed increases so will the risk of contamination, and the process of natural purification cannot be regarded as a trustworthy safeguard."

It will be seen that these remarks of Mr. Fuller's have reference to rivers whose suspended organic matter is almost entirely of vegetable origin. In countries more densely populated the character of flood pollution is more dangerous. If the current of a river be not sufficiently strong, the mud banks that deposit become in hot and dry seasons fetid breeding grounds of noxious life, while the shallows hold a strong solution of highly deleterious matter. From this cause many riparian epidemics arise in the time of, or just after, periods of warmth and drought. "Compensation" reservoirs, to divert floods and store the water so that the river becomes less overcharged, are also made necessary by the fact that the water, in addition to being turbid, is also greatly increased in foulness, as besides the washings of manured land and of streets in towns, numberless polluting objects from the smaller tributaries are carried by floods into the main stream. In this way small villages have produced epidemics in towns lower down the river. Intermittent stagnancy succeeded by flood is favourable to the growth and dissemination of the more dangerous organisms. However, the storm water in a reservoir has time to deposit, and forms a reserve against periods of drought. By deposition and oxidation the impurities become so reduced that the Royal Commission of 1897 on London Water concluded that "no restriction need be placed on taking flood waters."

With this object the new reservoirs at Staines and Walton have been authorised b Parliament, and are now in course of construction; they will furnish storage for 8,000 million gallons of unfiltered Thames water.

Weirs and dams form resting places fo much putrescent matter, and should have valves and arrangements for periodic cleansing. At the Sanitary Institute Conference on "Water Supplies," October, 1901, Mr. A. G Leigh urged the desirableness of a power o control over weirs and dams. He suggested that such powers would be most advantageously exercised by the rivers authority having jurisdiction over the watershed, and ought to comprise, amongst other things—(1) the removal of disused and abandoned weirs and dams; (2) all plans of proposed schemes for flushing to be subject to the approval of the authority; (3) the limited control over arrangements for flushing; and (4) the removal of any obstruction to the flow of the stream, as falls of earth, undue accumulation of stone and other adventitious matter. The Ribble Joint Committee's Report for 1900-1 observes :—"The mischief occasioned by the sludging of lodges and by weirs is very considerable, and any legislation enacted in the future might well embody clauses dealing with these."

In this way the purification of the water where it is taken for drinking supplies would be much facilitated, while sufficient healthy vegetable and fish life need not be molested.

PROTECTION OF SOURCES.

It is particularly important that authorities should have a complete control over their gathering grounds, especially when, as at Manchester, no filtration is practised before distribution.

Liverpool and Birmingham obtained power by their special Acts to acquire their watersheds, although the whole of their water was intended to be filtered. In America it seems preferred to make strict regulations for protecting purity of supplies rather than to purchase the areas. In a number of States the Boards of Health are empowed to issue rules and orders to prevent the pollution and to secure sanitary protection of all ponds and streams used by any city, town, or water or ice company as sources of water supply, together with all springs, streams, and watercourses tributary thereto, and to appoint agents to enforce the provisions of the Acts, their compensation being paid by the authority making application to the Board. In England, the numerous Acts having for their object the purification of our rivers have, to a great extent, remained inoperative, owing to the numerous excepting clauses. The pollution of streams is forbidden under penalties by the Public Health Act of 1875, the Rivers Pollution Act of 1876, the Local Government Act of 1888, and by special legislation dealing with different watersheds. It is the duty of an inspector of nuisances to prevent the washings of stables and pigsties from entering any watercourse, to insist on the removal of all privies on the banks of running streams, and to prevent the discharge into the water of all polluting matter from houses, under the Parish Councils Act of 1891. Any Parish Council can complain to the Rural District Council that it has not a proper water supply; and if the latter do not provide it, the application lies to the County Council, which has authority to make the provision. The Parish Council has no means of obtaining information, but the County Council is entitled to appoint expert officials, and can direct their medical officer, surveyor, and analyst to obtain the necessary details. Dr. Thresh has made an elaborate report on the water supplies of Essex, and the Glamorgan County Council has recorded the chemical and bacterial examination of all the county water supplies for the last 2½ years; and other County Councils are working in the same direction. Some central authority is, however, necessary to co-ordinate and arrange the statistics.

At the recent Water Supply Conference held in London (October, 1901), the following resolutions were submitted to the Council of the Sanitary Institute for approval, and I give after each resolution the action taken by that body.

1. In the opinion of this Conference the purity of the water supply throughout the country can only be effectively secured by placing such supplies in the hands of representative bodies directly responsible to the consumers.

The Council expressed no opinion upon this resolution.

(2) That it is in the interests of the kingdom at large absolutely necessary that county councils shall have large powers of supervision and control in respect of the question of water supply in their respective county areas.

The Council considered that this resolution was unnecessary, as the county councils already have large powers of supervision and control, especially with regard to the formation of joint committees under Sec. 14 of the Local Government Act of 1888, of which powers they have not generally availed themselves. Nevertheless, they hoped that extended powers in certain respects, such as power of entry, would be given to them, pending the creation of a separate Commission or new department of the Local Government Board as a Supreme River Authority.

(3) That the Council of the Sanitary Institute be asked to urge county councils to investigate the existing condition of the water supply within their district, with especial reference to the quantity and quality of such supply, and to the real or probable contamination of the springs and wells used for potable purposes.

The Council forwarded this resolution to the county councils, and suggested that in investigating the real or probable contamination of springs, wells, and streams used for potable purposes, special attention should be paid to careful inspections of the localities, and urged uniformity of action among the several councils.

The Interim Report of the Royal Commission on Sewage Disposal, issued July, 1901, "Considers it of the utmost importance that the simplest possible means should be provided for adequately protecting all our rivers," and that for some time to come scientific experiments should be carried out on the subject. "An authority guided by medical considerations might not unnaturally be inclined to insist on a degree of purity which may ultimately prove in certain cases to be uncalled for; while another authority, with its mind fixed on economy, might shrink from taking essential precautions." It advises "the creation of a separate Commission, or a new Supreme Rivers Authority......which, when appeal is made to them, shall have power to take action in cases where the local authority have failed to do so."

Miscellaneous.

THE MINERAL PRODUCTS OF JAPAN.

It is not generally known that Japan is rich in any minerals except copper, coal, and iron, yet she has furnished a certain proportion of the world's supply of the precious metals. It is true that as regards gold, the amount produced is small in comparison with the output of what are known as the gold-producing countries, and yet Japan was one of the countries whose fabulous wealth aroused the cupidity of Western nations in the time of Columbus, and Wataru Watanabe, a Japanese mining engineer, is authority for the statement that during more than one hundred and sixty years previous to 1776 Japan annually exported 1,600 pounds avoirdupois of gold and an equal supply of silver. The United States Consul-General at Yokohama says that the country is now producing more than the exports of the period referred to, although the mines, with one exception, are still worked by the wasteful system of a century ago, and Mr. Watanabe thinks that by employing proper methods there should be no difficulty in placing Japan among the gold-producing countries. He says: "Gold veins are very well distributed throughout the country, from Hokkaido in the north, to the farthest end of Kuishu in the south. Comparing the areas of other gold-producing countries with that of Japan, and computing the amount of the subterranean treasure from the respective areas, this country must be considered an excellent goldfield." Some new mines recently discovered in Kuishu are said to be very extensive. The value of the coal mined in Japan is almost equal to that of all other minerals combined. It is found in many regions, but the most important mines are in Hokkaido, the most northerly of the large islands and several adjacent islets. It varies from the hardest anthracite to peat. Modern machinery and methods have been introduced in the operation of many mines. The industry is mostly in the hands of the natives, although foreigners are permitted to own shares in some of the mining companies. Boring for petroleum is an industry of very recent date in Japan, and lack of experience and imperfect machinery have hitherto interfered seriously with its success. Echigo, a province on the western coast, has produced all except a very insignificant part of the oil thus far produced from native sources, but recent discoveries have given an impetus to this branch of mining in other parts of the Empire, and active preparations for boring are being made in a district in the north-east. Indications promising excellent results have been observed in the northern island also, and it is reported that European and American companies have been formed to exploit that region. Improvements are being made in the methods of procuring the oil and transporting it to the refineries in the province of Echigo, and it has been proposed to construct a pipe line from the mines to Tokyo, 200 miles distant. Iron mines believed to be very rich exist in the principal island of the Empire, but they are still very imperfectly developed owing to the lack of capital and experience. The arts and industries practised by the Japanese before the advent of the foreigner made little use of this metal, and it is only during very recent years that the people have begun to appreciate the value of their iron mines. The tardiness of private capital in undertaking the development of the iron industry caused the Government to take action in the matter, and in March, 1892, experts were placed on a committee which had been appointed by the Diet to make a thorough investigation of the iron ore beds, the process of smelting, and the organisation of a foundry. The result was very favourable, and the appropriation requested for initial experiments was approved. Alterations in the specifications resulting from an examination of the iron industry in Europe and America, made it necessary to ask for additional appropriations, and these were still further increased by the necessity for improving a harbour in connection with the works, thus involving a total outlay of £2,300,000. The preparations were completed, and the establishment began practical work last year. The Japanese Imperial Railway Department has been in successful operation for several years, and has manufactured some fine engines, which are in use on the Government Railway and other lines. Shipbuilding is also freely encouraged, and a Japanese company has secured contracts for the construction of several American vessels, all of which will tend to add impetus to the lagging industry of the iron mines. Copper, which was freely used in the arts of old Japan, has been mined in the country from very early times, and in the 17th century, when the trade with Holland increased so much that the supply of gold and silver was no longer adequate to settle the balance of trade, copper was substituted and gladly received by the Dutch traders, who carried away from 720 to 1,200 tons of copper annually. It still forms an important article of export, and the investment of capital in modern appliances resulted in more than doubling the value of the exports of copper from 1890 to 1900, again illustrating the superior efficiency of machinery as compared with cheap labour. The mines at Ashiwo, about 100 miles from Tokyo, are among the oldest in the country, and in 1885, under the primitive methods they used, yielded 3,000 tons of copper. They are still worked, and have lately occasioned much difficulty by reason of the poisonous fumes rising from the smelters and the injury to farms from the overflow of the drainage.

*AN AUSTRALIAN OSTRICH FARM.**

Some few years ago a South African visitor, travelling through the States now forming the Commonwealth, expressed surprise that some of the pastoralists did not try their hand at ostrich farming. They had both the right country and the right climate, and would find a shipment of feathers fully as profitable, if not more so, as a shipment of wool. But he was told that the idea was impossible, and that the ostrich farmer could have no place in the Australian industrial world. The erroneous character of this somewhat hasty conclusion has recently become demonstrated by some remarkable results achieved in a Sydney suburb, where an enterprising Australian has established an ostrich farm, which bids fair to prove the pioneer of many others in the parent State. The farm is situate near one of the immense headlands guarding the entrance to Port Jackson, and commanding a magnificent panoramic view of the waters of the broad Pacific. Here are to be found 22 fine healthy birds, seemingly quite at home in their respective kraals, or fenced-in areas, but the limited quantity of land at the command of the experimenter prevents any present increase in the number of birds. Each kraal is studded with clumps of bush, used more as a protection from driving sand than as shelter for the birds, which naturally, as in South Africa, prefer the open. The food consists principally of maize and vegetable matter, the feeding being by hand, although on a larger area it would be otherwise. The supply of water is limited, but this does not affect the health or appearance of the birds, which seems to possess something of the water-economising power of the camel. One of the ostriches, a noble bird, is known as the "Duke," and a beautiful fan made from his feathers was presented by a number of Sydney ladies to the Princess of Wales when visiting the Mother State. It was set in a tortoiseshell frame, and mounted with a crest of Australian gold. Some of the feathers obtained from the "Duke" are 27 inches in length, 15 inches in width, and of the purest white. In South Africa, the birds mature at three years, but in Australia two and a-half years is their full time. The feathers are most valuable when the birds are fully matured. After they are clipped, they are carefully strung and dried. When thoroughly dried they are graded, and then prepared by a staff of girls, sometimes as many as forty in number, for the workshop. The feathers command a ready sale, the supply generally being less than the demand. It is stated that the Australian feathers, as a result of better climate and better food, are superior to those imported from South Africa. No difficulty is experienced in obtaining young birds. The eggs are laid in the open, the number ranging up to twenty-eight, and the percentage hatched is considerable, as many as twelve chickens being obtained from a single clutch. The birds breed usually about three times in two years, generally during the cooler months. In South Africa, the eggs are hatched in incubators, so as to prevent damage to the wing feathers of the parent birds while sitting, but this expedient is found unnecessary in Sydney. The growth of the young birds is marvellously rapid, and there is no reason why, with sufficient space, their numbers should not become speedily increased a hundredfold. During the breeding season the birds display a vicious disposition, and have to be cautiously approached, their kicking powers being of the strongest and most dangerous, and generally exercised when least suspected. At such periods they can be handled with safety only by those experienced in their management. The best feathers in the European and American markets are obtained from Morocco, but they are closely approached by those from South Africa. Both, however, are rivalled by those from Sydney, which are declared by experts to be among the finest known. The introduction of birds and animals from other countries has not always proved advantageous to Australia, as witness the sparrow and the rabbit, but the acclimatisation of the ostrich would assist largely in increasing the national wealth.

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* Contributed by Mr. John Plummer, Sydney, Australia.

THE PRODUCTION OF SPARKLING MEDOC.

A new industry has sprung up in France, viz., the production of champagne in the Bordeaux district. The demand for claret having so greatly diminished in favour of the wines of Champagne, a large landed proprietor in the Médoc has started the production of sparkling wines, made on the same basis and by the same process as champagne is made. This wine is white and sparkling, and it may at first seem strange that white wine should be able to be made in the Médoc where only black grapes are grown, but this will be so only to those who are not acquainted with the manner of making champagne, for although a small quantity of wine produced from white grapes may be used, still champagne is almost entirely made from black grapes, and the most celebrated vineyards in the Champagne district are all planted with them. The colour of the wine, in fact, depends only on the way in which the wine is made. All the colouring matter is in the skin, while the fruit itself is colourless, or nearly so. If the whole of the grape, skin and all, be allowed to ferment together, the colouring matter in the skin will be dissolved in the juice of the grape, and the wine produced will be red. If, on the contrary, the skin be removed before the fermentation begins, the wine will be white. Consul Hearn states that the making of this wine requires much greater care than that of claret, and resembles more that of the Sauternes, where each grape is picked separately. The grapes are picked and sorted with the greatest care, and placed in large baskets, and then carried to a large wine-press, where they are spread out to a convenient thickness. If this is done so that no grapes be bruised or broken when the pressure is applied, the juice will run out white, and it is then allowed to ferment in special vats. This can be done in any wine country, but it is only natural to suppose that vineyards which have given delicate flavoured clarets may be expected to produce white sparkling wines, with the same qualities of delicacy and flavour as the red wine possessed, and these sparkling médoc appear to have. Sparkling wines require much more working and preparation than still wines, and a second fermentation has to take place when the wine is in bottle, and it is this which gives the gas. Any deposit that there may be in the wine has to be collected in the bottle close to the cork, so that when the first cork is withdrawn, the deposit is forced out and the bottle corked a second time. There are many other manipulations through which the wine passes, so that each bottle is handled nearly a hundred times by the time it is packed and ready for shipment. These operations have to be carried out, from first to last, under a perfectly even temperature, otherwise the fermentation would be irregular, and the wine would either be lacking in life, or else the pressure would be so great in the hot season that the bottle would not stand the strain; moreover, it would not be possible to get the wine perfectly clear and bright. For this reason, the cellars in the Champagne district are dug out often to a great depth in the chalk. It would have been impossible to find such cellars in the Médoc, where the soil is of a gravelly nature, but at Bourg, on the right bank of the Gironde, opposite the Médoc vineyards, there are cliffs of oölitic limestone, whence the stone has for centuries been quarried. It is of this stone that the city of Bordeaux is built. The stone has been quarried out in long galleries, which are now adapted for cool cellars, with a perfectly even temperature all the year round, and in these the sparkling médoc is made in identically similar circumstances to the wines of Rheims or Epernay. Such has been the devolopment of this new industry, that one proprietor has more than 600,000 in his Bordeaux cellars. Consul Hearn adds that to the ordinary taster, there is nothing but the label to distinguish the sparkling médoc from the best brands of champagne. Another white sparkling wine is made at St. Emilion, and the cellars are in the caves below the ruins of an old monastery, from which the wine takes its name.

BOTANIC STATION, TOBAGO.

This station was started in June, 1899, at Dealfair, a valley situated opposite the landing place at Scarborough. The site was selected in 1898 by the Imperial Commissioner of Agriculture and the Superintendent of the Royal Botanic Gardens of Trinidad. The soil is fairly good, and there is a regular supply of water from a small spring on the land. The first year's work consisted of clearing and preparing the land, making roads, paths and drains, and starting a nursery. The latter in 1899 contained 1,600 economic plants. In 1899 and 1900 the laying out of the Station was greatly advanced. In the latter year the nursery was increased to 7,500 economic plants, of which 2,157 were sold, bringing in an income of £15 7s. 3d. A large number of cacao and other plants were distributed free to settlers on Crown lands and others. Latterly, a house for the Curator, an office and a shelter for visitors have been provided. Also a new entrance rendering the Garden accessible from the landing place.

Attached to the Station is a travelling Agricultural Instructor whose chief duty it is to visit the holdings on Crown lands, and advise and assist the settlers. About 500 acres are estimated to be now in course of being planted, by settlers, in cacao trees. The Agricultural Instructor also assists generally in promoting planting industries in the island.

The Station is mainly supported from the funds of the Imperial Department of Agriculture, but the grant is supplemented, to some extent, by the Government of Trinidad. The Curator and Agricultural Instructor are departmentally under the Superintendent of the Royal Botanic Gardens at Trinidad. The Station is occasionally visited and inspected by the Imperial Commissioner of Agriculture.—*Barbados Agricultural News.*

General Notes.

Volcanic Dust.—Specimens of volcanic dust collected in St. Vincent and Martiniqe, during the recent eruptions, which have been placed by the Colonial Office at the disposal of the Board of Education, are exhibited in the Western Galleries of the Victoria and Albert Museum. To this exhibit there has been added some dust which fell in Barbados, with chemical analysis of the same, and drawings of the minerals which it contains.

Foreign Students at the University of Paris.—The Board of Education have received through the Foreign-office an intimation that the Council of the University of Paris have decided to publish annually henceforth in the month of April a programme of the University lectures which will be delivered in the academic year beginning in the following November. This plan has been adopted in order to enable foreign students, who may desire to attend the lectures, to make their arrangements conveniently in advance. The programme of courses for the academic year, 1902–1903, can be seen at the Board of Education Library, St. Stephen's-house, Cannon-row, Whitehall, S.W.

African Coffee. — The coffee known as the Highland Coffee of Sierra Leone, was introduced to the West Indies about six years ago, through the instrumentality of the Royal Gardens, Kew. It is quite distinct from either Arabian or Liberian coffee, and is admirably suited for cultivation from sea-level up to an elevation of about 800 feet. The botanical name (*Coffea stenophylla*), that is "narrow-leaved coffee," is a good name, as by this character and its small, dark-purple berries, it is readily distinguished from all other coffee. "Stenophylla" coffee has nowhere been more successful than under Mr. Hart's care at the Royal Botanic Gardens at Trinidad. It has grown there into tall, handsome bushes, 10 to 12 feet high, loaded with berries. It is singular that it has shown a marked tendency to be cross-fertilised by Liberian coffee, so that in the second or third generation its original characters have almost entirely disappeared. If this coffee is desired to be kept distinct, it must therefore be cultivated away from other coffee plants.—*Barbados Agricultural News.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1903.

The prize is offered to the student who obtains the highest awards in the following subjects :—

(*a.*) A finished drawing of imperial size from the nude living model.

(*b.*) A set of time studies, on a small scale, from the nude living model, executed in a short time, of varied shortly sustained poses (mounted on not more than two imperial size mounts).

(*c.*) A set of studies of hands and feet from the living model (mounted on not more than two imperial size mounts).

(*d.*) Drawing from the life, including memory life drawing, done at the Examination on May 9, 1903.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892, 1893, or 1896, cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Board of Education, South Kensington, in April, 1903. Each competing drawing must be marked "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Board of Education.

Proceedings of the Society.

CANTOR LECTURES.

THE PURIFICATION AND STERILISATION OF WATER.

By Dr. Rideal, F.I.C.

Lecture II.—Delivered January 20, 1902.

Reservoirs and Filter Beds.

The Royal Commission on Sewage Disposal, in their interim report, July, 1901, distinguished between natural and artificial processes. Any attempt at classifying the methods of water purification on these lines would be misleading, as nearly all the ordinary processes are parallel to those which occur in nature. We have seen that sedimentation plays the chief part in the natural purification of surface water, and filtration through porous strata in that from deep sources. A combination of the two under control is the basis of procedure in the majority of waterworks. That these processes, formerly looked upon as simply mechanical, had essential biological and chemical features, gradually appeared during the general use of open sand filters. It has been estimated that over twenty million people in Europe drink sand-filtered water. The primary idea of sedimentation reservoirs and of open sand filters was only to remove visible suspended matter, but it was found that they effected a greater purification than had originally been contemplated; it is only within the last fifteen years, however, that the rôle of bacterial action in this connection has been appreciated.

Such a remarkable relationship exists between the incidence of typhoid fever and a change in the water supplied to a town, that we are almost forced to regard the death-rate from this disease as the most significant criterion in judging of the purity of a public supply. A notable example in England of this coincidence occurred at Newark, where in 1893 River Trent water was replaced by water from deep wells in the New Red Sandstone: simultaneously the typhoid cases changed from about 6 per month to about 1 in two months, a reduction of over 90 per cent. Hazen and Fuertes have both elaborately discussed this coincidence, and conclude that it is safe to assume that all unpurified supplies involve a higher average mortality from typhoid. An investigation into the general bacterial quality is therefore required, although instances are rare in which the typhoid organism itself has been isolated. Turbidity, hardness, and the effect in causing incrustation in steam boilers are minor considerations, and in a sanitary sense of little value.

It is now generally recognised that any hard and fast limit for the total number of organisms present in potable water, like Koch's standard of 100 per c.c., is inadmissible, as waters of undoubted purity occasionally exceed this number, and, moreover, vary in bacterial content. Special tests are therefore employed to indicate the presence of certain varieties of bacteria, "sewage organisms," which should be absent in pure water, but are invariably abundant in sewage, such as *B. coli*, spores of *B. enteritidis sporogenes*, streptococci and staphylococci, and thermophilic bacteria. It It is of great importance to limit the quantity of water examined, as they are occasionally isolated from pure waters when a very large volume is tested. Some years ago I pointed out that the ratio between the total number of organisms and those growing at blood-heat would indicate the possible contamination of a water, since an increase in the latter would denote admixture with sewage. From a great number of examinations of water in this way, I found that, as a rule, a pure water contained less than 10 per cent. of such blood-heat organisms.

Coli organisms are present in less than a litre of some London waters, and I have isolated spores of *B. enteritidis sporogenes* from 3 litres of a London company's water (see Lecture III.) These two organisms are, however, present in crude sewage to the extent of more than 100,000 and about 500 per c.c. respectively, and it follows that a contamination of 1 in 100,000 would yield positive results for *coli* in a few c.c. Houston concludes that a pure water should not show the presence of *coli* in as much as 100 c.c. or even more of the water, that *B. enteritidis sporogenes* should not be detected in from 100 to 500 c.c. and streptococci from 10 c.c. According to Pakes deep well waters should be entirely free from *coli*, and waters from other sources containing *coli* in less than 20 c.c. should be condemned, and only in quantities greater than 100 c.c. considered safe. Horrocks suggests 200 c.c. as a limit for *coli* and 2 litres for the detection of *B. enteritidis sporogenes*. I have occasionally obtained streptococci and staphylococci from a few c.c. of deep well waters of great organic purity. Thermophilic bacteria growing luxuriantly at temperatures above 50° C. are not present in pure waters (Miquel), but are numerous in drain-water and sewage.

To imitate the improvement effected by deposition in lakes, and also to increase the storage capacity, artificial lakes are often made by building a dam across a valley; in other cases the whole reservoir has to be built. The latter has the advantage that the water can be more carefully guarded, as the banks, besides being on private ground, are usually raised above the surrounding surface. There is often an increment from springs rising from below; in some cases this may be permitted, and a plain earth or gravel bottom can be allowed for the sake of cheapness in construction, but where the basins have to be constructed in polluted or marshy soil, the bottom and sides must evidently be watertight. The banks must always be carefully protected. This is shown by the fact that dead animals have sometimes been found in them, and that prosecutions for bathing in reservoirs, even in those for storage of filtered water, have been enforced, as occurred not long ago in the East-end. Live animals also should be prevented access, as in drinking they often communicate internal parasites. Regulations for the protection of a watershed may fail in times of frost, as drainage which in summer sinks into the ground and becomes filtered, in winter may flow over the frozen surface, or be washed down after a thaw. It has been repeatedly proved that cold does not kill many pathogenic organisms, so that typhoid outbreaks have often occurred suddenly after frost, as notably at King's Lynn in 1892, and at Plymouth, Pennsylvania, in 1885.

The rate of deposition depends on the stillness of the water and on the character of the solids. Settling reservoirs are used in two ways: in one the water is merely checked in its velocity and flows through continuously, in the other it comes to rest for a time, and is drawn off intermittently. The second method might at first sight seem to give the better sedimentation, but in practice it is impossible to refill a basin without disturbing a good deal of the previously deposited sediment, and moreover there is found to be a great tendency for currents to be set up in filling, due to differences of density between the incoming water and that left in the reservoir. The choice of methods in general depends on the area available and the requirements of the supply. The length of time required for subsidence must depend on the amount and nature of the turbidity. Flood waters often require months to clear, and in this case the reservoirs must have considerable capacity, as at Staines, or the old system of stopping the pumps during periods of maximum turbidity must be adopted. After the height of the flood the stream clears itself, as Hazen remarks, by the flowing away of the turbid water, much more rapidly than the water clears itself by sedimentation in the reservoir.

Subsidence is almost always necessary before any filtration, as otherwise the filters rapidly become clogged. In London there is no fixed rule, as the number of days of storage depends on the capacity of the reservoirs and the condition of the river. At present the companies have storage varying from about four days to three weeks supply. The new works at Hamburg provide 1 to 1½; at Berlin, Rotterdam, and many American cities, only 1. The main deposition, amounting to about 75 to 90 per cent., occurs within 24 hours; the longer period allowed in London has chiefly the object of storage against floods. As the solids left in suspension grow finer, the weight of each particle decreases so much more rapidly in proportion to its surface, that the relative friction in descent increases, and the settling becomes very slow. An example of this was shown in the Cincinnati investigation, where a very muddy water deposited in 24 hours 62 per cent.; in 48 hours, 68; in 72 hours, 72; in 96 hours, 76 per cent. of its suspended matter. In these experiments, however, 72 hours was fixed upon as the best period with regard to the removal of bacteria, which in 24 hours only averaged about 20 per cent., in 72 hours was 75 per cent., and then proceeded much more slowly or ceased. The average improvement resulting from 62 hours subsidence was in per cents.; suspended matter, 73; organic matter—nitrogenous, 45; carbonaceous, 42; bacteria, 62. (State Report, 1899, pp. 100-115.) Even a comparatively clear water is sometimes bacterially improved by sedimentation, thus Tils ("Zeits. f. Hygiene," ix., 212) found that the Freiburg water supply, derived from a mountain stream, contained fewer bacteria in the reservoir than at the source. In ordinary river water the improvement is very marked. At the Grand Junction Waterworks, Hampton, in 1892, P. Frankland found:—

Place.	Colonies per c.c.	Percentage reduction.
Intake from Thames, June 25	1,991	..
First small storage reservoir..	1,703	15
Second ,, ,, ..	1,156	42
Large storage reservoir, leeward side	464	77
Ditto windward side	368	82

showing also the influence of the wind, the windward side being sheltered by the bank.

At the West Middlesex Waterworks:—

	Colonies per c.c.	Percentage reduction.
Thames water at Hampton ..	1.437	..
After first storage reservoir ..	318	78
,, second ,, ..	177	88
New River water—		
Cutting above reservoir ..	677	..
Outlet of first reservoir....	560	17
,, second ,, ...	183	73

This observer remarks that by storage alone the waters of the Thames at Hampton and the purer water of the New River Company's channel are brought to about the same bacterial level.

An instance of the removal of the typhoid bacillus by sedimentation occurred during an epidemic in Philadelphia in 1891. Four of the better built and drained, and usually healthier wards of the city, with a population of 184,000, had a typhoid death-rate of 172 per 100,000, whereas the rest of the city showed 64, and a usual average of about 35. The city was supplied from a subsidence reservoir, but the four wards, on account of their elevated position, pumped their water direct from the river.

As to the most suitable depth for settling basins very varying opinions are held. In America they are usually large and shallow, the water rests, as we have seen, for 24 to 72 hours, is then screened to remove larger living matter, while sediment is removed at regular intervals, depending on its amount. In England a depth of 12 ft. to 16 ft. is generally recommended. The sides are preferably vertical as the vegetable growths and sediment which collect on sloping sides become putrescent as the water level varies, but this precaution has not been adopted at Staines. Deeper settling basins allow a longer period without cleansing, and also favour deposition, since below 20 feet, water is stagnant for most of the year, and subsidence is not interfered with by currents. In the small lake at Saratoga, Currier found the number of organisms per c.c. to be at surface, 56; 13 feet below, 54; 32 feet below, 163. But on account of growth and other circumstances this condition is frequently reversed. Thus in a lake in the Herzegovina, Karlinski ("Centr. f. Bakt.," xii., 220) found the organisms per c.c. to be—near the banks, 16,000; surface in the middle, 4,000; 16 feet deep, 1,000; 32 feet 600; 40 feet to 50 feet, 200-300; at the bottom when the mud was disturbed, 6,000. The Massachusetts Board in 57 reservoirs and ponds found that diatomaceæ and chlorophyceæ grew more abundantly in the deeper ones (more than 25 feet), while cyanophyceæ and protozoa incline to shallower water. There is, therefore, no distinct preference on the score of organisms. A stronger reason, however, in favour of a depth of not more than about 16 to 20 feet is the fact that active oxidation of organic matter only takes place towards the surface, since in lower layers the oxygen is used up by organic matter, and not renewed by circulation. This is shown by analyses of two reservoirs in the Massachusetts reports:—

Depth.	Temperature. Centigrade degrees.	Percentage of saturation with oxygen.	Temperature. Centigrade degrees.	Percent. of saturation with oxygen.
Surface ..	24·2	100	23·6	79
10 ft. below	24	100	19	83
20 ft. ,,	12	49	12	36
30 ft. ,,	5·8	29·5	9·5	21·3
40 ft. ,,	5·6	0	9·0	20·9
45 ft. ,,	5·2	0	9 0	1·65
50 ft. ,,	..	..	7·5	0
57 ft. ,,	..	..	7·0	0

Adeney (*Proc. Roy. Dublin Soc.*, iii., 25, Sept., 1900) found the following dissolved gases in a reservoir at different depths:—

Depth below surface in feet.	Gases in c.c. per Litre.			Per cent. saturation with oxygen.
	CO_2	N	O	
5	16·67	13·03	5·71	87·7
20	19·54	13·23	2·00	30·23
Ditto. another experiment.	19·34	13·39	2·23	34·48

The loss of oxygen is accompanied by an increase in the carbonic acid and nitrogen in about the proportion existing between the carbon and nitrogen in the organic matter present in the water. The organic sediment is, however, first hydrolysed and dissolved by the anaerobic and semi-anaerobic liquefying bacteria, and in deep reservoirs the fluid at the bottom increases in colour and organic matter in solution, and may acquire an unpleasant odour, so that if accidental admixture occurs, the entire contents of the basin may be spoilt. This is a reason for the adoption of shallow settling reservoirs, which are somewhat frequently cleaned, when, as is frequent in America, the water is supplied direct from them unfiltered: where filtration is subsequently practised (the only really safe course), the liquefaction of the organic sediment may be an advantage. The remaining deposit changes from a very fluid state to a thick fluid in two or three weeks, and from this time becomes more and more consistent, and, with impure waters, assumes a black colour, owing to the reduction of sulphates and of ferric salts and the formation of ferrous sulphide. The residue of the organic matter is of a humous nature, practically inoffensive, and possesses the agricultural value of humus. Like peaty matters generally, it has the function of encouraging, when in small quantity, the nitrifying action in the final oxidation, and itself undergoes slow oxidation to carbonic acid, water and nitrate. I have described its properties in a paper at the British Association, Glasgow, 1901 (*Chem. News*, Sepember 27, 1901). It will be seen that the details of procedure of sedimentation will on the whole depend on the character of the raw water.

Assisted Sedimentation.—Purification by agitation with solid particles and subsequent deposition has been practised for ages in the clarification of wines and other liquids. Its application to waters was suggested by the following considerations:—

1. The more suspended solids present, the greater and more rapid was the percentage removal by deposition. Example:

	I.	II.	III.
Parts per 100,000 of suspended solids.............	96·5	39·3	13
Percentage removal in 3 hrs.	85	24	17
,, ,, ,, 24 ,,	96	66	32
,, ,, ,, 48 ,,	97	73	41

2. It is seen under the microscope that the organisms are collected for the most part within and round the solid flakes, therefore, the subsidence of these removes the organisms also, as is shown by the immense numbers of the latter found in sediments.

The first systematic experiments were made by P. Frankland in 1885 (*Proc. Roy. Soc.*, 1885, and *Proc. Inst. C.E.*, 1886). Using large quantities of material he found that with spongy iron, chalk, charcoal, and coke the reduction of bacteria was 90 to 99 per cent. in half to 48 hours; other materials were not so effective. Kruger ("Zeits. f. Hyg.," 1889) and V. and A. Babes ("Centr. f. Bakt.," 1892) employed lower, but still impracticable proportions, and obtained much less reduction. Similar results were obtained by the Massachusetts Board. The more porous and slowly subsiding substances, as would be expected, carry down many more organisms than those which are more compact. But the treatment with inert matters has been abandoned, because of—

1. The results not being equivalent to the cost.

2. The rapid redistribution and remultiplication of the organisms, as to which we shall speak later.

Filtration. — Just as sedimentation in settling basins was an imitation of the natural purification that occurred in rivers and lakes, so filtration in limited areas follows the same lines as percolation through porous soils and rocks. There are, however, certain differences. (1) Ordinary soil on account of its lime and clay has a power of absorbing organic matter which is absent in sand. (2) The quantity of liquid passed through filters is largely in excess of even the most copious rain, of which only a part sinks into the soil. (3) The particles of soil are many of them much finer than the sand of filter beds. (4) Filters are usually worked continuously, the sand being saturated with water, whereas soils have intermittent periods during which air is drawn into the pores. Two great divisions have come to be recognised in ordinary modern procedure:—1st. Slow filtration, associated with the old filter beds; 2nd. Mechanical or rapid filtration; commonly called respectively the English and American processes. The first requires a large bed of fine sand, through which water passes by its own weight at the rate of about 5 to 10 cubic feet per day per square foot of surface, or an average of 4 inches in vertical distance per hour. In the other, the water is mechanically driven through a much smaller bed at a rate of 200 to 400 cubic feet per day per square foot, or 8 to 16 feet vertically per hour, equal to about 40 times the rapidity of the first process.

Sand Filters.

Sand filters were first regarded simply as strainers for turbid water, and the fineness and cleanness of the sand as the most important point. Analyses later proving that the soluble constituents were considerably affected, an explanation was sought in surface action. Afterwards from the fact that nitrates and carbonic acid were formed, a chemical theory of simple oxidation arose, involving a free supply of air.

Three discoveries, however, threw a new light on the process.

1. The size of the finer mineral particles is only about $\frac{1}{100000}$ inch (0·25 μ), and that of most bacteria $\frac{1}{25000}$ inch, or larger (μ to 5μ), but both are smaller than the interstices between the grains of even fine sand, consequently it follows (*a*) that the clearing is not accounted for by simple straining, (*b*) that the organisms would be retained first.

2. Piefke in Berlin, about 1886, found that sterilised sand effected hardly any purification and did not retain microbes. It had previously been noticed that sand filters did not become efficient for some days after re-laying.

3. When the oxygen or air, and the water, were sterilised little or no oxidation of organic matter occurred.

It was proved, therefore, that for the proper mechanical and chemical effects the action of organisms is essential. It must be remembered that some organisms have long flagella, while a large number, such as diatoms and bacteria, are normally surrounded by a gelatinous envelope which greatly increases their size, and enables them to adhere to sufaces, so that in a short time the sand in a new filter becomes covered with a living slimy layer which entangles suspended matters and effects the main part of the purification. This is called "schmutzdecke," and sometimes the "schlammdecke," or mud-covering, and until it forms the filtration is inefficient. Kemna states that at Antwerp the most effective strainer is *Hydrodictyon*, a green alga forming a hexagonal network and giving a carpet-like coating which, when it becomes clogged, can be easily detached and rolled away. I have also myself noticed in the mechanical filtration of London water in the summer months that the algæ form this green-baize coating very rapidly, and that the use of coagulants is then unnecessary. It has been proposed to seed the schmutzdecke with specially active or liquefying organisms, but I cannot recommend such a procedure.

In the under layers of sand the nitrifying organisms, which work best in the dark, act as they do in soils, causing oxidation, and producing nitrates by the aid of the dissolved oxygen. Green algæ in their growth evolve oxygen, and so increase the amount in solution, while bacteria as a rule diminish it. Although the chief removal of organisms occurs in the "schmutzdecke," the lower layers of sand are not inactive, as Reinsch has shown at Altona. For an example, he gives the average number of organisms per c.c. as:—Raw water, 36,000; just under the schmutzdecke, 1,800; at bottom of sand (35 inches), 44.

By the accumulation of deposit, the filtration is made slower, and, at the same time, the filtrate is at first bacterially improved, but to keep up the supply the head of water must be progressively increased. When the head reaches a maximum the water has to be drawn off, and the upper sand pared off to a depth of about half an inch, or down as far as it is discoloured. The paring is repeated when necessary, but, after a time, depending on the quality of the water, it becomes imperative for the whole mass to be renewed, for three reasons:—

(1). The thickness of fine sand becomes too much reduced. (In Germany the legal limit is 12 inches.)

(2). A growth of some bacteria through the filter occurs, and the numbers in the effluent become too high. A study of the organisms present in the raw and filtered water shows that not only the number is diminished, but that a sorting of the different species also takes place.

(3). The sand becomes foul by decaying organic matter, and the algæ may also communicate a bad odour and taste.

In most places the sand is washed by hose or machines and replaced, but in countries where sand is plentiful, as in Holland, fresh material is used.

After renewal the water will not be fit for use for a period depending upon circumstances, so that extra filters must be available for replacement. At Berlin Piefke finds that to reduce the organisms in the filtrate below Koch's limit of 100 per c.c., the filter must have been at work for at least eight days, but the interval given is in most places less. The formation of the upper active layer is there hastened by running on some of the top layer, or "ripe sand" from a previous cleaning. In England the layers are usually transposed, fresh washed sand being laid below, and the old sand on top.

Underneath, the sand is always supported, to prevent washing through, by layers of progressively coarser material, generally coarse sand, fine gravel, coarse gravel and then the underdrains. The safety of a sand filter as a purifier depends upon careful laying, the principle being that the material should be properly "graded" by screening and sifting, that no stratum should rest on another more than three or four times as coarse as itself, and that each layer should be of uniform thickness, and sound at every point. Without this attention, sinking occurs, channels are formed, and the filtration, as has frequently happened, is made unreliable. It must be emphasised that all filters should be worked with periodic bacterial tests: the mere clearness of the water is no index of safety, as bacteria in numbers may be present in an apparently clear water. Chemical analyses should also be made at intervals, with special reference to (1) possible leakage into the plant, (2) hardness, (3) state of nitrification and aeration. Special dangers have frequently been revealed by variations in the chemical composition, attended by changes in the character of the organisms, though not always by an increase in their number.

Time will not permit me to enter into the details of construction and management of sand filters, which belong indeed more to engineering, but I shall have to mention a few chief points. Koch's rules, adopted at Berlin, Hamburg, and many other places, are as follows:—

1. *Rate of Filtration.*—No water must pass through a filter at a rate of more than 100 m.m. or about 4 inches, per hour, equal to 2,174,000 gallons per acre per day. The rates in practice have been given in inches per hour, as:—East London and West Middlesex 2½, Southwark 2·7, Chelsea 3·3, New River and Grand Junction 4·0, Lambeth 4·1; Carlisle 2·2, Leicester 3·4, Leeds and Liverpool 4, Bradford 4·2, Dumfries 8·5, Amsterdam 1·5, Bremen 2·4, Hamburg 1½ to 2, Stuttgart 3·3, Altona 4, Berlin 2½ to 4, Zurich 11·5 to 16·4. At Buda-Pesth, the rate at first (in 1892) was 12 inches per hour, and the effluent was

not satisfactory; afterwards it was found that it had to be reduced to about 2 inches for a good result. About Zurich there are several exceptional features. The lake water, which is run on to the filters, has undergone an unusually good natural sedimentation, and is already of high purity. The filtering bed is laid with 4 inches of garden soil to promote nitrification, 4 feet of fine sand, and the rest gravel. The conditions are strongly oxidising, as in warm weather a scum of algæ, called "water-bloom," forms on the water above the filter, and has to be skimmed off, since it rapidly blocks the bed, and gives the water a bad taste. The same difficulty often occurs in America. That a slow rate is not always proportionally beneficial is shown by some experiments reported by W. Kummel, at Altona. He found that with a velocity of 40 m.m. (1·6 inches) per hour, or 4 feet per day, the number of micro-organisms varied from 11 to 97, at 100 m.m. (4 inches) per hour from 5 to 79, at 200 (8 inches) from 7 to 72 per c.c. But in London and elsewhere it is observed that any sudden increase of rate by an extra head or other cause, or any disturbance of the filter, is followed by augmented numbers of bacteria in the effluent. On the whole, the limit of 4 inches per hour seems a safe maximum rate, but the permissible velocity will vary for different waters, and for the same river at different seasons, and, therefore, must be constantly adjusted in the light of the bacterial analysis.

The rate of filtration depends on (*a*) the quality of the raw water, (*b*) the fineness of the sand, and to a less extent on the thickness of the layer; (*c*) the pressure corresponding to the effective head of water (this is less at the bottom than at the top of a filter bed, on account of the friction in passing through the sand), (*d*) the temperature; near freezing point, according to Hazen, the yield is only about half that at 77° F. (25° C.).

The head of water required in a new filter or after cleaning may be only a few inches, but must be increased as the surface slime developes. In England the surface is usually cleaned when for a proper rate the head exceeds 3 ft., but in some other places a much higher level is reached, as at Schweinfurth 4 ft. 3 in., Hudson, N.Y., 6 ft. With open filters the depth of water must be greater in winter than the thickness of any ice that is likely to be formed, in order to prevent freezing of the sand, which renders the filter unsafe, as in the well-known cases at Altona in 1892 and 1893. For this reason in cold climates sand filters have to be covered.

Others of Koch's rules are:—

(2) Each filter must have a contrivance by which the movement of the water in the filter can be restricted to a certain pace and continually regulated, and must further be provided with an arrangement by which samples of the filtered water may be taken at any time.

(3) A bacteriological examination by cultures must be made daily.

(4) Water containing more than 100 germs per c.c. must not be allowed to pass into consumption. Although this is an arbitrary rule it is one which may be regarded as tolerably safe, although, of course even when such a small number is permitted in the filtrate, pathogenic organisms may be present.

The total area of filtering surface required obviously depends upon the maximum daily demand and the filtering rate, an addition being made for supply while any portion is being cleaned.

The area should be divided into surfaces of moderate size, not exceeding one acre, so that any filter can be readily disconnected.

Size of Sand.—Although, as we have already shown, the fineness of the medium only partially explains the efficiency of a filter bed, the size of the grains, and particularly of the smallest, affects the speed of filtration, while with finer grades the filter clogs quicker, and washing is more difficult.

Effective size of sand grain "is the diameter than which 10 per cent. of the mass by weight is smaller, and 90 per cent. larger in size."

Uniformity co-efficient "is the ratio of the diameter of the sand than which 60 per cent. by weight is finer, to the diameter than which 10 per cent. is finer." Thus, if 60 per cent. of the sand is less than 0·50 millimetres, and 10 per cent. is less than 0·25 millimetres, the "uniformity co-efficient" is $\frac{0·50}{0·25}$ or 2, while the "effective size" is 0·25.

A low uniformity co-efficient implies regularity in size and large water spaces; a high one means greater irregularity and smaller voids. The average size in mixed sand is always greater than the effective size, and it was found at Lawrence that the 10 per cent. of finer sand has as much effect on filtration as the 90 per cent. of coarse. In Holland the finest sand is used, of an effective size of 0·17 to 0·19 millimetre; no sand is re-washed, new being always used for refilling. These waters, however, are nearly clear before filtration, or the beds would soon become obstructed. By sand of 0·04 to 0·06 millimetre, water can be rendered sterile, but the rate of delivery is impossibly slow, and the use of pressure is not satisfactory. The factors most suitable must be regulated by local circumstances and by tests of the effluent; their chief use is to secure uniformity and intelligent control. The following Table gives a few particulars from various sources :—

	Thickness of sand.		Rate of Filtration in gallons per square foot.			Effective size.	Uniformity coefficient.
	Max.	Min.	Max.	Min.	Mean		
London—	ft. in.	ft. in.				mm.	
East London ...	2 6	1 6	1·33	1·33	...	0·40	2·0
New River	2 3	1 7	2·3	1·9	...	...	...
West Middlesex	2 9	...	...	...	1·25	...	...
Grand Junction	3 0	1 6	1·9	1·3	...	0·40	3·6
Southwark	2 9	2 3	1·6	1·5	...	0·34	2·5
Lambeth	3 0	2 6	2·4	2·1	...	0·36	2·4
Chelsea............	4 6	3 6	1·75	1·75	...	0·36	2·4
Liverpool	...	...	...	...	...	0·37	2·6
Leeds	...	2 0	...	...	1·9	...	...
Berlin	2 0	1 3	2·4	2·0	...	0·35	1·8
Average of five large German towns	...	...	...	...	...	0·34	2·0
Lawrence, Mass. (intermittent)...	5 0	...	...	...	1·8	0·25	...

Intermittent filtration, adopted as above indicated at Lawrence, as the outcome of the Massachusetts State Board experiments, was based on the results obtained with sewage, and the great improvement effected by nitrification. This, as already mentioned, occurs in the underneath layers of sand, and requires, not only the presence of the proper nitrifying organisms, but also, as a condition for their activity, the provision of oxygen in considerable quantities. Thus I have pointed out elsewhere, ("Sewage Purification," 2nd ed. p. 100) that one gramme of organic nitrogen requires :—

For production of	Grammes of Oxygen.	Litres of Oxygen.	Litres of Air.	Litres of Oxygen saturated Water at 7 c.c. per Litre.
N_2O_5	2·85	2·0	10·0	286
N_2O_3	1·7	1·2	6 0	170
N_2O_2	1·13	0·8	4·0	114
N_2O	0·57	0·4	2·0	57

Many sewages contain 5 parts of nitrogen per 100,000 in objectionable organic forms, equal to 1 gramme in 20 litres: to convert this into harmless nitrates demands about half its volume of air, constantly supplied, or an admixture with about 15 volumes of water fully saturated with oxygen. Hence, at Massachusetts, the filters were periodically allowed to empty of water, refill with air, and rest for aeration, as practised in the intermittent system of sewage treatment. But the system has been adopted at very few waterworks for the following reasons :—

1. The output of water was so much diminished by the rest periods that either the area must be greatly increased, or the filters must be made to work much faster.

2. The result in the latter case will be a reduction in the degree of bacterial purification.

3. The periodical disturbance of the bed by the intermittent inlet of water will be also unfavourable.

4. Ordinary waters contains so much less organic matter that there is an ample supply of dissolved oxygen for their purification. In controlling filters this feature must be ascertained by the chemical analysis.

In some cases water has been supplied to filter beds in the form of spray or fine rain to carry air into the sand, but without advantage in proportion to the expense, and with the same fault of disturbance. With properly arranged continuous filters, much aeration is introduced in the lower layers of gravel.

Double Filtration.—Waters are occasionally met with which are not rendered bright by sedimentation for a practicable time, and a single passage through a sand filter. As already stated, such impurity, if of inorganic nature, is not of hygienic importance. But in some cases there is an imperative demand for a bright water, and if no other supply be available, a second filtration will be necessary. In this instance the first filters may be of somewhat coarser, and the second of very fine sand. Polluted river waters containing more than 100,000 organisms per c.c. cannot be satisfactorily dealt with by even the best single filters, as the number of organisms left in the effluent will always be high and above the arbitrary standard of 100 per c.c. suggested by Koch. It is impossible, therefore, to approve of any scheme of single filtration alone under these circumstances. At the present time it would seem that preliminary sedimentation in storage reservoirs must be an essential part of any proposal to utilise such waters for drinking purposes, unless the municipalities are prepared to adopt further means of purifying the effluent. It is obvious that a second filtration at the works would complish this object, and it becomes a uestion whether such will be more econoical than the construction of storage reseroirs. I have already pointed out that in rivers f small volume the necessity of storage reseroirs in flood time has been brought about by crease of population, and that consequently, most cases, the combination of storage eservoirs and single filters will be preferred, wing to the additional advantage of augnented volume.

The Grand Junction Company has already dopted a system of double filtration, which is pplied with more or less regularity, with a hickness of sand, for final filtration, of $1\frac{1}{2}$ to 3 eet, and an average rate of 1·23 gallons per quare foot per hour (equal to 2·36 inches ertically per hour, or 1,280,000 gallons per cre per 24 hours).

In Paris, since 1897, the ordinary supply from prings has been supplemented in times of xtra demand by river water from the Marne, purified by settling channels and by slow filtration through fine sand, as in London. In 1899 similar works were installed at Ivry for double filtration, to treat 35,000 cubic metres (7,700,000 gals.) per day of Seine water by channels and sand filters as above, preceded by preliminary coarse filters on the Peuch system. These are in three compartments, filled with gravel of different sizes, are easily cleaned, and are said to remove two-thirds of the organisms and three-fourths of the suspended solids, besides saving frequent disturbance of the top film on the beds of fine sand.

SERVICE RESERVOIRS, OPEN OR COVERED.

It may be laid down from experience, that the purer waters from deep wells or unpolluted upland sources, if stored at all, must be kept away from air and light, as bacteria multiply in them very rapidly, and they otherwise become quickly fouled by algæ and animal life. Surface waters, on the other hand, are often much improved in open storage by the bleaching action of light and by oxidation, while the bacteria tend to diminish in numbers.

Miscellaneous.

BY-PRODUCTS OF THE STARCH INDUSTRY IN THE UNITED STATES.

There are a number of by-products produced in the manufacture of starches from cassara, potato, corn, wheat, and rice. By-products in the manufacture of rice starch are the rice hulls, which are used mainly as fuel and packing material, but are also ground up and used for the adulteration of spices and the higher grade food stuffs. Wheat starch is generally made by one of two processes:—(1) Wheat flour is made into a dough, and the starch washed out in suitable machines, the gluten conglomerating and separating as a tenacious, sticky mass. This is dried, and forms the wheat gluten of commerce. It is used as a food article or as a mixing product to raise the percentage of proteids in low grade foods. Its utilisation is still in its infancy, and its application to the arts is in the experimental stage. (2) Wheat flour is allowed to sour or ferment, and then the starch is separated mechanically on "starch runs," the gluten being taken off as a thin fluid, which is generally not recovered. If recovered, it is dried, and gives a product similar to that made in the first process. The cassara starch industry is confined in the United States to Florida. The manufacture, according to a report recently issued by the United States Chief Statistician for Manufactures, is still in the experimental stage, and no reliable data are at hand. For potato starch, the potatoes are peeled and ground, and the starch washed out and separated by mechanical processes. The by-product is "potato slop," which is used as a cattle food. The potato and cassara industries are of small importance. About 99 per cent. of the starch manufactured in the United States is made from corn, the daily minimum consumption being about 180,000 bushels, yielding 2,500,000 pounds of starch, and 4,000,000 pounds of glucose or sugar. From a manufacturing standpoint the kernel consists of four parts—starch, gluten, germ, and bran, of which the gluten, bran, and germ are by-products. These by-products are separated by mechanical means, the process being somewhat as follows:—Corn is soaked in moderately warm water for from twenty-four to sixty hours, to which a very small amount of sulphurous acid has been added to prevent fermentation and to loosen the intercellular tissue between the starch and gluten cells. The excess of water is then run off and the wet corn ground in such a way that the germs are loosened without being cut up or broken. The whole mass is then run into separators, where the free germs are floated off as wet germs. These are dried in suitable dryers, then ground to a flour and the oil extracted by hydraulic pressure, leaving the corn oil cake as a by-product. The product forms one of the staple cattle foods, and contains about 24 per cent. protein and 10 per cent. fat. The nutritive and digestible properties are very high. Ground oil cake is known as germ oil meal. The average production is about 2 to $2\frac{1}{2}$ pounds per bushel. Over 50 per cent. of it is exported. The corn mass, free from the germs, is then ground very fine, and run over bolting cloth sieves. Here the bran of the corn is separated, and remains on the sieves. The product remaining in the bolting cloth sieves is pressed, and, combined with about 50 per cent. of water, is sold for immediate consumption

It is known by various names, as "glucose food," "slop," "corn food," "sugar food," &c. It heats and quickly deteriorates in the wet condition, but can be preserved for a time during hot weather by salting. This same product dried is known as "corn bran," "dried glucose," or "sugar food." The food is easily digested, and competes directly with wheat bran. Its composition is about 11 per cent. protein and 3 per cent. fat. Mixed with the gluten meal described below it forms gluten food. The yield per bushel is about 4½ pounds. The substance passing through these sieves mentioned above is a mixture of starch and gluten. The starch is separated by gravity from the gluten, the mixture being run over long level planes, as starch tables, "runs," or "gutters," where the starch settles out as a firm mass, and the gluten passes away at the ends. This gluten is settled, and gives what is termed "wet gluten." The starch taken from the tables is used as the raw material, for the manufacture of the various grades of commercial starches, or it is treated with acid and converted into various grades of glucose or grape sugars. The wet gluten, pressed and dried, forms gluten meal, the composition of which is: protein, 38 per cent.; fat, 3 per cent., and starch, 40 per cent. This is one of the richest and best food products on the market. The nutritive value is very high, and the factor of digestibility ranges from 92 to 96 per cent. The yield per bushel of corn is about 5½ pounds. The gluten meal is treated for the recovery of its starch, and gives two new products, a concentrated food-stuff characterised by the large amount of proteids (60-70 per cent.) it contains, and a maltose syrup. This food-stuff is suitable for human consumption, and also for raising the percentage of proteids in foods that have a small amount of these substances. When the wet bran and the wet gluten are mixed in the proportions as obtained from the original corn and the mixture dried, the resulting food is known as gluten. This is the most common food product in the starch and glucose industry, and represents about 80 per cent. of the food output. Its feeding value is very high, and its digestibility above 90 per cent. Its composition is about 28 per cent. protein and 3 per cent. fat. Corn oil cake and gluten meal are extensively exported. The bran and gluten food are used almost exclusively in the United States. The production per bushel of corn is about 12½ pounds of food, giving a maximum daily production of from 1,200 to 13,000 tons, valued at £5,000.

*CHEMINS DE FER VICINAUX, BELGIUM.**

The conditions under which lines of local interest are conceded in Belgium are determined by the laws of 1884 and 1885, founding the Société Nationale des Chemins de Fer Vicinaux, which practically has t monopoly of light line concessions in the country.

The capital necessary for making each line is su scribed by the Government, the authorities of t province interested, and a small portion by individua Instead of paying in to the Société Nationale the tot amount of their subscriptions, the public authori can issue annuities, calculated at about 3½ per cen extending over a period of 90 years. The society also authorised to issue bonds, the interest of whi at 3 per cent., and the reimbursement in 90 years a guaranteed by the Government. Individual subscribe must, however, pay in cash the amount of their su scriptions as the calls are made.

The Société Nationale therefore represents t subscribers of the capital for making each vicin railway, and it acts for them in everything th regards the construction and eventually the equipme of the various lines. This society is constituted wi a variable capital, representing the sum of the capita subscribed, increasing with the formation of each ne line. Moreover, as the society has an official characte the Government has the right to keep a check upo its operations, especially as regards fares and carriag rates

The working of the vicinal lines is generally l by contract to companies constituted with th object, and undertaking to conform to the specific tions regulating the conditions of working. Som of the conditions as to the duration of the concessio the caution money to be paid to the society, an the general conditions of working are common to a these contracts. The element which differs in the is the remuneration of the company that undertake the working of a line, and the society, that is to say the shareholders, the apportionment of these two re munerations being known by the name of "formul d'exploitation," and based upon the gross receipts each line. As a general rule, the share of the work ing company is a more or less considerable fractio of the gross receipts, being about 55 or 60 per cent.

Inasmuch as the Société Nationale hands over th light railway with all its appurtenances and the roll ing stock to the working company, the latter may b constituted with a very small capital; and this circum stance gives rise to great competition when the work ing of a vicinal line is to be let, thus procuring ver favourable conditions of working for the share holders in the line. At the same time, as th remuneration of the working company cannot be les than the expense of working, generally comprise between 50 and 55 per cent. of the gross receipts, the society reserves the right of not being obliged to let contract to the lowest tenderer.

The portion of the receipts that fall to the lot o the working company serves to reimburse the expens of working and current maintenance and to remune rate its capital. Of the portion attributed to the society, a portion serves to defray its own genera expenses, and the balance constitutes the profit o the lines. Each individual balance is due in it irety to the shareholders in the corresponding line, accounts for each railway being kept separate.

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* From a communication by M. Cruysmans to the Antwerp Section of the Liege Engineers' Association.

If the profits permit, the public powers receive a st dividend equal to the amount of the annuities bscribed, while the fully paid up shares of indiluals receive 4 per cent. If there is a surplus it is vided between the shareholders and the reserve funds.

Thanks to the facility for obtaining capital at easy es, this financial organisation permits, not only of dowing the country with a network of light railys, which now exceeds 2,000 km. (1,242 miles) in ngth, and of contributing to the economical devepment of a large portion of the country, but also of cording cash remuneration to the public powers if e results of working permit payment to the shareIders of dividends higher than the annuities bscribed.

Out of a hundred lines now in active working, ore than half enjoy these advantages; and the areholders of the other lines, with the exception of ree, receive every year dividends which are variable, ut inferior to the amounts of their annuities.

TURKISH MEERSCHAUM.

In the vilayet of Brusa, which is exceedingly rich in inerals, meerschaum can be extracted by any person t Sari-Son, Sépétdji, Gheïkli, and Menlon, on payent of about eleven pence, in English money, to the dministration of Mines—the cost of a permit. The ines of Sari-Son are situated at a distance of about 7 miles to the east of Eskichehir. The first pit was pened at Sari-Son twenty years ago, but to-day here are 8,000, of which only 2,000 are worked, the est being abandoned. Some 4,000 miners work in hese mines, and every Friday a market is held, at hich they dispose of the blocks of meerschaum they ave extracted during the week. For the accommolation of the workmen, some 1,000 huts have been rected. At the village of Sépétdji, situated about 18 miles to the north-east of Eskichehir, there are ome 20,000 pits on a space of six miles—east to west, of which only 150 are worked, all the others being exhausted. It is said that these mines were opened 1,000 years ago, which is not incredible, as it is well known that the mineral, which consists of silica and magnesia, was formerly used for many purposes other than the fabrication of pipes, moreover, fuller's earth, to-day disdained, used to be worked on a vast scale by the ancients. These mines are worked by some 500 miners, who live in the surrounding villages. At Gheïkli, in the neighbourhood of Sépétdji, there are 3,000 pits, of which only 100 are worked, and these by 400 miners. Finally, the only other place where the Administration of Mines authorises meerschaum to be extracted is called Menlon, and here there are only 20 pits, actually worked by 100 workmen. It is stated that these mines were opened 2,000 years ago. Vice-Consul Gilbertson says that the working of these meerschaum deposits, called the Eskichehir Mines, which formerly were actively worked, and extended from Kahé to Mikalitch, is now reduced by their concentration round the town of Eskichehir, to 1,770 pits, giving employment to some 5,000 miners, the greater proportion of whom are Kurds and Persians. These deposits are worked on the following primitive system:—A foreman or ganger, having from 2 to 15 men under his orders, having pegged out a piece of ground, generally a yard wide, a pit is sunk until a red, clayey earth, which is generally the first sign of the existence of magnesia, is reached. Sometimes this is reached at a few yards from the surface, but ordinarily they have to dig down some twenty yards, and often forty, and even up to sixty yards, before reaching this red earth, wherein the meerschaum is disseminated in kidney and other irregular forms, the greater part of them being the size of a walnut or an apple. On reaching the gangue containing the blocks of meerschaum, the miners drive horizontal shafts through the red clay. This, however, is no easy matter, as they cannot detach or pick off very much of the clay at a stroke. Some of these galleries are no less than a quarter of a mile in length, and it sometimes happens that owing to these being pierced at random, different gangs meet underground. They work night and day, the galleries being lighted with petroleum, and after a certain quantity of blocks have been extracted, the meerschaum, still enveloped in its gangue, is drawn out of the pit and stacked in the miner's barracks. These blocks are bought by the *luledjis* (pipe manufacturers) of Eskichehir, in job lots every Friday, and there are some 150 such persons who regularly attend these markets. The meerschaum is then taken to Eskichehir, when the blocks are cleaned, the operation consisting of scraping and cutting the blocks with a sharp instrument or knife, the meerschaum being still soft and easily cut into any shape or form. Over 1,000 persons are occupied in cleaning and shaping these blocks, which, after being thoroughly cleaned, are separated into four classes, according to size and quality. The blocks being ready for sale, a bargain is struck between the *lulidjis* and the commission agents and merchants at Eskichehir, of whom there are about a dozen. The latter then pack the blocks of these four classes, with very great care, into boxes of equal size, each block being wrapped in cotton, to avoid any friction or shock between the pieces. For commercial purposes, these four classes are named as follows:—Tira-mali, Birem-birlik, Pamboukli, and Dakmé. The annual output of the mines varies between 120 and 150 tons. The Eskichehir meerschaum is very highly prized in Europe on account of its superior quality; and as these deposits, notwithstanding that they have been mined for centuries, are still considered to be inexhaustible they ought, in Vice-Consul Gilbertson's opinion, to constitute, if scientifically and economically worked, a very important source of revenue to the Turkish Treasury.

WOOD FUEL.

Mr. D. E. Hutchins, whose valuable paper on "Forestry," read on November 22nd, 1899, will be in the remembrance of those members who are interested in the subject, raised in *Nature*, of the 10th of July, a rather novel question in connection with the supply of timber. He suggests that it would be worth while to cultivate the wattle or eucalyptus vegetation in Australia or South Africa, with a view to its being used as fuel. He argues that eucalyptus planted on tropical mountains would produce wood fuel at the rate of 20 tons per acre per year in perpetuity, and points out that, by a calculation of Helmholtz, a eucalyptus plantation would store up about 1 per cent. of the solar energy received on the unit of area. Its dry timber, which weighs 60 pounds per cubic foot, as compared with coal weighing from 50 to 52 pounds, is said to have an equal or higher thermal power than coal. As these calculations were made from natural forests, Mr. Hutchins argues that by selection and cultivation, even double the amount might be produced where there was a powerful sun, a heavy rainfall, and a very rapid forced growth. Very large districts of the world would supply the requisite conditions, and he looks forward to a yearly output of over 40,000 million tons, or even on an average forest yield, of 20,000 million tons, the world's yearly output of coal being calculated as 663 million tons. The suggestion is certainly a novel one, but its merits and its practicability must be left to be discussed by experts on the subject.

THE PRODUCTS OF CENTRAL ANNAM.

Central Annam enjoys a moderate temperature, the heat of its dry summer being rendered endurable by the sea breeze. The principal native cultivations are rice, sugar-cane, manioc, earthnuts, maize, and tobacco. According to the soil, from one to three harvests of rice a year can be obtained. The sugar-cane of Annam is highly prized, great quantities of the raw sugar being shipped to Marseilles. Maize is also exported in large quantities, and is appreciated on account of its small hard kernel. The cultivation of the earthnut is remunerative; the oil is used for lighting, for lubricating, and for food by the natives. Tobacco grows well, although it is cultivated only for native use. It is, according to the *Bulletin de Géographie Commerciale*, almost certain that if it were treated by European processes it could compete with other Oriental tobaccos. There are already manufactories installed in Cambodia and in Annam. Rubber and gutta percha exist in considerable quantities; they come from wild bindweeds, and the natives extract the gum without any method or care. Samples have been sent to France, and the quality is pronounced to be good. Coffee succeeds very well, and large plantations have been made, but the most important cultivation in the future will be that of tea. This shrub was brought from China by missionaries more than a hundred years ago, and is now completely acclimatised in Annam. The souchon Annam is highly appreciated, and the net pric relatively low. The mountainous part of Anna relatively rich in quartz and coal. A society mining exists at Nong-Son. Although this mine i a distance from the port of Tourane, the transportat by river is cheap. A gold mine is also being wor at Bang-Mui, 43 miles from Tourane; the aver yield is one-third to two-fifths of an ounce per t The country produces benzine, cardamom, cott and bamboo. A trade in skins, horns, and elepha tusks is also carried on. Albumen is made from eggs of poultry, and is sent to France for in the preparation of skins. Manual labour is v cheap—especially agricultural—and there are nun rous unexplored valleys where concessions of land c be easily obtained.

Obituary.

Mr. Andrew Yule, senior partner of the fir of Andrew Yule and Co., Calcutta, and George Yu and Co., London, East India merchants, died the 11th inst., at his residence, "Braeside," Dulwic wood-park. The *Times* mentions that Mr. Yu went out to India in the early sixties, and found the well-known business which has since beco identified with his name. He joined the Society i 1895, and was a valued member of the Indian Co mittee, in whose work he took great interest. M Yule was in his 68th year.

General Notes.

Utilisation of Sugar Waste.—The "Notes issued by the "West Indian Committee" in Londo contain an account of a method of utilising the coars molasses produced in the manufacture of sugar fro the cane. The process, which is the invention o Mr. George Hughes, consists in preparing cattle foo of the molasses and megass, or waste fibre of th cane. This food has been named "molascuit," an is believed to be worth £6 or £7 per ton, while ever as a new material it will now sell readily at £5 to £ per ton. The mixture consists of 20 per cent. of fine and absolutely dry cellular fibre of the sugar cane and 80 per cent. of molasses, in fact, the original juice in the fibre is replaced by the molasses. The mixture is in good condition naturally, but is improved by further drying with hot air, not exceeding 212° Fah., or sun. Of the absorbent fibre 50 per cent. is digestible, which means in other words, the manfactured art icle should not contain more than 10 per cent. of woody fibre. A great advantage of the process lies in the fact that this cattle food can be shipped in bags, and in a condition that commends its use to the British agriculturist. The fibre can be obtained by passing the megass through a Carter's disintegrator and screening the product.

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FRIDAY, AUGUST 1, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the General Examinations (Grade II.) held in April last are now ready.

Copies for gratuitous distribution to each candidate who attended the examination have been sent to each centre. Additional copies can be obtained, price 6d. each.

The results of the Preliminary Examinations (Grade I.) are nearly ready, and will shortly be sent to those centres having candidates in that Grade.

The Examinations for 1903 will commence on Monday, March 30th.

The Programme is in preparation, and will be issued very shortly.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1903.

The prize is offered to the student who obtains the highest awards in the following subjects :—

(*a.*) A finished drawing of imperial size from the nude living model.

(*b.*) A set of time studies, on a small scale, from the nude living model, executed in a short time, of varied shortly sustained poses (mounted on not more than two imperial size mounts).

(*c.*) A set of studies of hands and feet from the living model (mounted on not more than two imperial size mounts).

(*d.*) Drawing from the life, including memory life drawing, done at the Examination on May 9, 1903.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892, 1893, or 1896, cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Board of Education, South Kensington, in April, 1903. Each competing drawing must be marked "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Board of Education.

Proceedings of the Society.

CANTOR LECTURES.

THE PURIFICATION AND STERILISATION OF WATER.

By Dr. Rideal, F.I.C.

Lecture III.—Delivered January 27, 1902.

Use of Coagulants.

Coagulants are substances which, when dissolved in waters, yield more or less flocculent precipitates which entangle bacteria and suspended solids, and in most cases also combine with colouring and other matters in solution, so facilitating purification by subsidence and filtration. The addition of vegetable juices containing tannin, as those of barks and woods, was known in very early times, and is mentioned in Exodus xv. 23. The tannin carries down iron and lime and many other impurities, and is assisted by the vegetable mucilage. Organic matter, however, is left in the solution, in which bacteria rapidly grow and develope putrefaction.

The salts of alumina, which are the coagulants most frequently used in America, are, as regards ordinary native alum, referred to by the ancients as possessed of clarifying properties. When added in small quantity to natural waters, the chemical reaction with carbonate of lime occurs, and aluminium hydrate is precipitated in a gelatinous form. Besides the mechanical function alluded to in the last lecture, in speaking of assisted sedimentation, that of entangling and carrying down bacteria and suspended solids, or clarification proper, hydrated alumina also has the power we are familiar with in dyeing, of combining with, or "mordanting," colouring matters and many dissolved substances, so effecting a chemical decolourising and purification. The equations with two ordinary forms of alum are:—

Potash alum.

$$K_2SO_4, Al_2(SO_4)_3 + 3\,CaCO_3 + 3H_2O = 3CaSO_4 + K_2SO_4 + Al_2\,(OH)_6 + 3CO_2.$$

Ammonia alum.

$$(NH_4)_2SO_4, Al_2(SO_4)_3 + 3CaCO_3 + 3H_2O = 3CaSO_4 + (NH_4)_2SO_4 + Al_2(OH)_6 + 3CO_2.$$

From these reactions several important points can be concluded.

1. As aluminium forms no stable or definite carbonate, carbonic acid is liberated and may be evolved as gas, the bubbles preventing the precipitate from settling. This gas has a slight germicidal effect, so that some of the bacterial improvement may be due to its liberation.

2. Aluminium salts have an acid reaction, therefore if, as frequently is the case with inferior waters, more of the coagulant is added than the calcium carbonate present can precipitate, the liquid will be rendered acid, and may contain an excess of alum, and be unfit for use. On a small scale carbonate of soda is sometimes added, either concurrently or afterwards, to remedy this defect, but, besides the cost, it does not act in a satisfactory manner, and if too much be employed, it will redissolve some of the alumina. A further fault of carbonate of soda is that in its commercial forms it is liable to contain impurities. As an alternative, lime is sometimes added, which has the further advantage of removing the carbonic acid; its use will be further described under softening.

3. The sulphates of potash and ammonia remain in the water, hence instead of alum, sulphate of alumina is now used, which contains about half as much again of alumina, and is cheaper and more soluble. The average amounts required for river waters in America are stated as from 3 to 4 grains per imperial gallon, or with subsidence, from 2 to 2½ grains. With very muddy waters much of the reagent is absorbed by the suspended solids, hence previous settling should be adopted.

Iron salts have also been used. With ferrous salts there is a danger of the water remaining ferruginous. Ferric sulphate (persulphate of iron) has lately been highly recommended, as it removes sulphides as well as the matters affected by alum. It is, however, generally slightly dearer than aluminium salts, and less convenient in use. "Aluminoferric," a crude sulphate of alumina containing a little iron, presents some advantages. It is hardly necessary to say that any precipitants must be used in proper calculated proportions, and that waters must be analysed from time to time, since their composition fluctuates.

In 1897 a number of experiments were tried with electrical methods for the purification of the Ohio river water. Mr. Fuller concluded that:—(1) The direct application of electricity produced no substantial purification; (2) it was possible to purify the water to a satisfactory degree by the action of hydrate of alumina electrolytically yielded by aluminium plates; (3) that this method possessed the advantage over the use of sulphate of alumina that it did not require addition of lime; (4) that it was, however, costly and irregular; (5) the substitution of iron for aluminium plates reduced the cost, but the results were inadequate.

Treatment with scrap metallic iron, followed by filtration, has been fully described in a lecture before you by Mr. Anderson (*Journal*, February 14th, 1896), so I need only mention that the process, which is in use at Antwerp, Dordrecht, and other places, is very successful with many muddy waters, such as that of the Nile. With peaty waters, however, it has been found to be often less satisfactory.

SOFTENING.

Softening from a trade point of view is beyond our present subject, but I must briefly describe its effect in coagulation and the removal of bacteria. The latter action was investigated in 1886 by Percy Frankland, who gives the following example of the difference between subsidence alone, and preceded by softening. The water contained at first 85 organisms per c.c.; after 18 hours rest they had multiplied to 1,922 per c.c. In a second sample treated with lime by Clark's process with the same period of rest, the organisms had diminished to 42, or a reduction of 51 per cent. Kruger, in 1889, obtained a higher reduction, but used too great a quantity of lime. The Massachusetts Board found that the percentage of removal of organisms tended to increase with the amount of lime employed. It has been repeatedly suggested that the London waters should be subjected to a softening process. Mr. Dibdin (London County Council's report, May, 1896), experimenting with the New River water, found that lime equivalent to 9·4 parts of CaO per 100,000 (6 6 grains per gallon) caused the following percentage reductions: red colour 100, yellow 35, in Lovibond's scale; albuminoid ammonia 23, oxygen absorbed 25, hardness 64, sediment nearly 100, organisms 87. Even waters containing a small number of organisms such as those derived from deep wells are bacterially improved. Thus, in my examination of periodical samples of a company's water from a deep chalk well from 1899 to the present time, I found the average removal of organisms to be 67·6 per cent. It has been proposed to use lime as a precipitant in the storage reservoir, and a portion of the precipitate so formed as a coagulant to form the artificial top film in a sand or mechanical filter. At Cincinnati a process on these lines was tested in 1899, and it was found necessary to apply an excess of lime water in order that the fine clay particles might be aggregated into relatively large masses. With a suitable degree of coagulation, the effluent of the sand filter was brilliant in appearance, and very low in its contents of bacteria and organic matter. The water was rendered alkaline and was liable to subsequent precipitation, hence it was necessary to apply carbonic acid after the treatment. This is on the lines that had previously been used in England by Archbutt and Deeley in their well-known softening plant. A somewhat similar method of purification is contemplated for the supply of Washington, D.C. The use of lime as a coagulant in the storage reservoir also ensures the absence of plumbo-solvent properties in moorland soft and acid waters, and as the further bacterial removal required is less, the rate of the subsequent filtration, if resorted to, can be augmented.

MECHANICAL FILTERS.

Within the last five years mechanical filters have received in America an extensive investigation, and installations for public supplies with a total daily capacity of 300 million gallons are at work in upwards of 150 cities and towns of the United States and Canada. Before 1893 the system was in use for the clarification of turbid and coloured river waters for manufacturing purposes, but it is only since the very exhaustive researches of Weston, Hazen, and Fuller that the hygienic importance of these filters for potable waters has been appreciated, and it has now been proved that rapid or mechanical filters are able to give very good results, especially with the assistance of coagulants. The method has advantages in certain cases, and will undoubtedly extend in Europe, where at present Moscow in Russia, and a few places in England, are, I believe, the only installations. It would be advisable for English engineers to institute trials in this country parallel to those which have been given in America to slow sand filtration, as recent practice has been to do away with the sand-filtered supplies from rivers, and to go to the mountain and upland surface waters, many of which, containing vegetable colouring matter, would seem to be very amenable to this mechanical filtration. These waters also frequently give rise to plumbism. With a mechanical filter using sulphate of alumina and lime (or even lime without alumina), if the water is not sufficiently hard from carbonate of lime the coagulant would correct that evil; so that with this process we should effect the removal of colouring matter and prevent lead poisoning as well. That our method of sand filtration seems generally to give a better bacterial purity than the mechanical filters may be due to the fact that the latter have been worked at too high a rate, and perhaps with a minimum quantity of coagulant, without due regard to the reduction of bacteria—a difference that doubtless could be remedied.

It would appear from the experimental results obtained by Simin at Moscow Waterworks, and from general considerations, that the special features of the American system are:—

(1.) The facility of renewal and adjustment and the smaller area required.

(2.) The cost of filtration by rapid filters and by open slow filters being about the same, in cold countries the necessary protection of the former can be more economically attained.

(3.) The greater removal of colouring matter.

(4.) An increase in the rate has not such an effect on the working as in English filters. "At the Moscow experimental plant a satisfactory effluent is obtained with a rate of 150 inches per hour, and it remains practically the same up to 250 inches."

A mechanical gravity filter has the form of a wood or steel tank, with a horizontal strainer of perforated metal (brass or aluminium bronze) supporting a bed of two to five feet of sand or crushed quartz. A heavy frame, on a central upright shaft, carries a number of rods projecting vertically downwards, forming a rake. When the sand becomes clogged, it is washed by reversing the current, forcing filtered water in from below through the strainers, at a pressure of 6 to 10 pounds, and revolving the frame and rods as soon as they are free to move, the wash-water, after flushing out the subsidence basin, being then run through a bye-pass till clear. Five to ten minutes is usually found sufficient for cleansing, and it is repeated every 8 to 24 hours, according to the quality of the water. The rake is then stopped, and the filtration continued, only a small portion of the first filtrate being allowed to run to waste. The use of the rake is not only for thorough washing and aerating, but also to keep the large and small grains of sand equally mixed. In the new gravity filters, arrangements are made for the surface of the bed to be raked or stirred at intervals, so as to lessen the frequency of washing. The plants are fitted with steam pipes, and connections for sterilising the beds, aided by a solution of soda-ash for cleansing, which is found desirable about once in six months. At Providence, Rhode Island, the rate of filtration is 100 million gallons per acre per day, with a head of 5½ to 6 feet, and 0·5 to 0·75 grains of aluminium sulphate is used per gallon.

When coagulants are required, the solutions are prepared in separate wooden tanks, and automatically mixed with the raw water in proper proportion. The liquid then enters a settling tank, being given a circular motion round the basin by a deflecting flange, in which the supply pipe terminates. The rotary motion, and the eddies produced by the upright timbers and pipes, are found, as is noticed with flocculent precipitates in chemical analysis, to cause the coagulated flakes to amalgamate into larger masses, and to settle more quickly afterwards. In this way from 50 to 75 per cent. by weight of the suspended solids are removed, and 30 to 70 per cent. of the bacteria, while the finer flakes pass on to the filter bed, and form an artificial *schmutzdecke* or top film. The usual time allowed for subsidence in a 15-foot filter, according to Mr. Weston, is from 25 to 40 minutes. In the Jewell apparatus, for the sake of compactness and protection, the filter chamber is in the same casing as the subsidence basin, and above it, and the almost clarified top water flows through a central tube over the top of the sand, and is drawn off by pipes below having strainers with holes about 0·03 inch in diameter. An automatic controller keeps the rate of filtration constant. In some other forms the subsidence basin is separate. With sulphate of alumina followed by lime it is proved that ordinary care ensures that the filtered water is free from alumina. The alumina sulphate is generally a basic salt, containing 17 to even 22 per cent. of Al_2O_3, the normal crystallised salt only containing 15·32.

Comparing the rates of filtration, that of the London water companies is about 2½ million gallons per acre per 24 hours, while a mechanical filter will pass in the same time 100 million gallons per acre; therefore the area required can be greatly reduced. This rate obviously involves a coarser material; this in the United States is commonly crushed quartz with an effective size as high as 0·6 mm., which, as seen from Table XI,, is much larger than even the coarse sand of the present London water filters, and about three times that of the finer sand recommended on the Continent. The coarseness of the material also involves, for effective filtration, the agglutination of the suspended matter into much larger masses than is necessary when a finer grade is resorted to, and this is most conveniently obtained rapidly by the use of coagulants. The wash water is mostly allowed to run back to the river, but none of it need be lost—as in Lexington, Ky., for example, it all goes through a settling basin and coarse filter, and then is returned to the filter. At that place about double the quantity of wash-water is stated to be required to clean the filters when algæ are giving trouble than when the chief difficulty is mud. It is also said that the loss by washing of the white sand used there was only 4 inches in 14½ months.

Coagulation by sulphate of alumina followed by lime water was advocated in America by Frederick A. Paget, and was patented by him in England in 1874. The method was adopted generally by the Jewell Company as a preliminary for their mechanical filters, as they found that not only was the improvement greater, but there was an actual saving of 30 to 50 per cent. in the aluminium salt, with but a trifling expense for lime. Alumina has been for many years regularly tested for in the filtered water by the reaction with fresh logwood and acetic acid as prepared for this purpose by Mrs. Ellen Richards, of the Massachusetts Institute: one part of Al_2O_3 in 6 million parts of water gives a blue colour. The test is always negative, except in rare cases, when the filter is out of order; the water is then rejected till the fault is remedied.

Whenever sulphate of alumina is used as a coagulant alone, an equivalent quantity of the temporary hardness is rendered permanent. In soft river and moorland waters, when lime is used in addition, an equivalent quantity of permanent hardness is added to the water, according to the equation:—

$$\overset{341}{Al_2(SO_4)_3} + \overset{222}{3Ca(OH)_2} = \overset{155}{Al_2(OH)_6} + \overset{408}{3CaSO_4}.$$

The 341 parts of sulphate correspond to 750 parts of an ordinary commercial alumina salt containing about 46 per cent. of water, and would give 408 parts of calcium sulphate. Thus, a mean quantity of 2 grains of sulphate of alumina per gallon would yield 1·1 grains of sulphate of lime, a quite trifling amount which is considerably exceeded in many good natural waters, and could, if it were wished, be avoided by the substitution of soda for the cheaper lime. Both sodium and calcium sulphates in these small quantities are absolutely without physiological effect. Officers of health in some 40 or 50 towns where the coagulants have been in use for periods up to 17 years attributed no ill effects to their use, and the water has no injurious action on pipes or boilers.

Quite recently a new coagulant is reported to be in successful use at Lorain, Ohio. Scrap iron is exposed in a revolving drum to the action of sulphurous acid from burning sulphur, and steam. The solution of ferrous sulphite is precipitated by lime, and the hydrated oxides of iron run directly on to the filter instead of alumina. It is said to be cheaper, and to give good results. The hardness is not affected, and its action is independent of the alkalinity of the water.

For large plants a number of filters are arranged in batteries.

In pressure mechanical filters, the receptacle is closed and the water is forced through by pumps. In small plants, as for hotels, the system has advantages, but from experience it is not adapted for large scale public supplies, as the filtration is apt to be less efficient, and control and examination are more difficult.

In England pressure filters of various types have long been employed for purifying water for trade purposes. A form made by Bell Bros., of Ravensthorpe, Yorkshire, and used largely by manufacturers for treating river waters in Scotland, Lancashire, and Yorkshire, is also extended to domestic purposes and to town supplies, as that at Crewe, dealing with 1,540,000 gallons, and at Prestwich, Scotland, treating 40,000 gallons, per 24 hours. It includes the use of "chemicals," presumably lime and soda, for softening, and of an alumina salt as a coagulant. The water mixed systematically with the reagents is forced under a pressure of 5 lbs. per square inch on to the surface of, and through, a bed of sand about 3 feet deep, and is collected by straining pipes below. Every 24 hours, or as soon as the pressure-gauge shows that the filter is clogged, the sand is cleaned by forcing in clean water through the strainers from below, and revolving an agitator different in form from that of the Jewell. It is stated that one-tenth of a grain per gallon of the chemicals is often sufficient, that the inclusive cost of softening and filtration will be about ½d. per 1,000 gallons, and that a million gallons per day can be purified on 600 sq. ft., equal to 72,600,000 gals. per acre per day. The cost of the plant seems to be about the same as the Jewell, the former being given as £2,500 per million gals., and the latter as £4,000 per 1,666,000 gals. (imperial). As to the bacterial results I have no information.

At York, where a supply of 6,000,000 gallons daily from the River Ouse is treated by settling basins and open sand filters, the water company, owing to the very bad state of the water during part of the year, and the consequent expense in cleaning and renewing the beds, have lately introduced Jewell mechanical roughing filters, with alumina coagulants, for preliminary purification. The four tanks, made of cypress, work by gravity, and are capable of dealing with three million gallons per day. The system is guaranteed to give the following results, viz.:—

"The filtered water shall be practically free from matter in suspension and colour.

"In the case of the unfiltered water containing 1,000 or more bacteria per c.c., there shall be a reduction of not less than 90 per cent. in the filtered water. In case of the unfiltered water containing less than 1,000 per c.c., there shall not be more than 100 in the filtered water.

"The filtered water shall not contain a greater quantity of alumina after than before filtration, and there shall be no increase of hardness in the water, due to the use of a coagulant."

In comparison it may be mentioned that the requirements of the New York State Board of Health are "When the number of bacteria in the unfiltered water is 3,000 or more per c.c. there shall be a bacterial reduction in the filtered water of not less than 97 per cent. When the number of bacteria in the unfiltered water is less than 3,000 per c.c. the average number in the filtered water shall not exceed 100."

The new plant of the Wolverhampton Corporation consists of two 15 feet Jewell gravity filters each capable of filtering 530,000 gallons per 24 hours; they will be independent of any other filtration system. The supply is drawn by two electrical centrifugal pumps from a small river, and the filtered water is discharged into the reservoir at the Cosford pumping station of the municipal waterworks.

As to the bacterial efficiency of mechanical filters with coagulation, the following results have been recorded in America by different observers :—

	Date.	Observer.	Organisms per c.c. in filtrates.	Average per cent. reduction.
Providence, Rhode Island	1893-4	Swarts.	2 to 63	98·6
" " "	1899	Swarts.	0 to 61	98·7
Long Branch, New Jersey	1889	Chapin.	2 to 5	98·7
Lorain, Ohio	March to August, 1897	Baumhardt.	Average 44	98·0
" "	June to July, 1897	Hollis and Flynn.	3 to 80 Average 14	97·2
Westerly, Rhode Island	1897	Main.	1 to 10 Average 3·3	99·1
Louisville, Kentucky	1897	Fuller.	—	99·0
Norfolk, Virginia	1900	McCormick.	Average 12·8	96·0
Cincinnati, Ohio	1898-9	Fuller.	160	99·4
Richmond, Virginia................	1899	Mallet and Levy.	2 to 61	97·5
Louisiana, Missouri................	1899	Ravold.	36 to 72	97·3
Washington, Columbia	1900	Miller.	—	99·0
East Albany, New York	1901	Caird.	—	99·5

Sterilising Filters.

Sand and mechanical filters in good condition, and under favourable circumstances, occasionally yield a sterile effluent. But such a result cannot be depended on, and to attain it a much finer medium must be employed. At this date it is hardly necessary to refer to the large variety of filters formerly trusted, which have been proved by Plagge, Sims Woodhead, Guinochet, Johnston, and others, to be quite inefficient in preventing the passage of bacteria, though they may render the water bright in appearance. These filters were really worse than useless, as they formed a cultivation bed for organisms of all kinds, including pathogenic forms, and actually sometimes increased their numbers.

The only filter that has stood all tests is the Pasteur-Chamberland. This so-called "candle-filter" originated, as is well-known, from Pasteur's laboratory experiments in preparing germ-free broth cultures for bacteriological investigations, when Chamberland introduced the practical application to drinking water of the tubes that Pasteur had found efficient for excluding bacteria. The same remark applies to these as I have made in connection with sand filters, that the removal is not accounted for entirely by a mere straining by the material, as the bodies of some of the organisms are smaller than the pores, though the gelatinous envelope of the bacteria and their entanglement, joined with the much greater fineness and evenness of the medium, and the consequent slowness of filtration, make the removal complete. But there must be also some molecular attraction dependent on the material of the tube and its manufacture, as a large number of fine-grained substances, to the naked eye apparently identical in texture, have been tried and found to be unreliable. Even with the Pasteur filter it is stated that "it requires the highest skill in pottery to produce a uniform result as to sterilising capacity, and some 30 per cent. of the finished tubes are rejected on test." Candle filters are manufactured by the Sanitats Porzellan Fabrik at Charlottenberg, and in this country several English-made candle filters have appeared. At present, however, there is no sufficient evidence to warrant the belief that any of them give the protection against water-borne disease which is afforded by Pasteur filtration, and the assumption that they function similarly is a very dangerous one for the general public, who are unable to distinguish between the forms.

In use the unfiltered water passes through the filter tube or tubes from outside inwards. This may take place under the pressure of a water main, or of a force pump, or by the pull of an exhaust pump, which may deliver into a separate filtered water chamber, or under the suction of a long syphon tube. Under some circumstances, the mere head of water in the filter chamber above the candle can be used, but the yield is then slow. In another form the candles are fitted into the top of a closed reservoir, from which the filtered water is removed by a hand-pump, which creates a partial vacuum in the filtered water chamber, and thus augments the rate of filtration. The filter may consist of one tube or of any number of tubes delivering into a common reservoir made either in one with the filter or separate from it. Care should be taken that the receptacle is dust-proof. The output varies with the pressure. Taking account, however, of the diminution which occurs through deferred cleaning, it may be said that the average yield per tube is about half a gallon per day without pressure (that is under the mere head of water in the unfiltered water chamber), and eight gallons per day with pressure.

The Nordmeyer-Berkefeld filter is one of the forms that have come in competition with the Pasteur-Chamberland, and aimed at a much greater rapidity, but at a sacrifice, as we shall see, of safety. It is made of kieselguhr, or infusorial earth, in the same form as the Pasteur, but of much greater thickness. The material, however, is much more porous than the porcelain, and allows the water to pass with about five times the rapidity, which would be a great advantage if it were not for the fact that it is permeable to pathogenic bacteria contained in water. It was, nevertheless, thought that it was sufficiently resistant to give protection against water-borne disease, and the entire British forces in South Africa in 1899 were equipped with it. They notwithstanding suffered enormously and constantly from typhoid fever, a result which, when contrasted with the practical results obtained from Pasteur filtration, threw doubt upon the filter's capacity to arrest the pathogenic organisms. This has since been tested directly at the Hygiene Laboratory of the Royal Army Medical School, at Netley, by Prof. Horrocks, and it has been found that the typhoid bacillus, even in water without any nutrient addition whatever, penetrates the Berkefeld filter in a few days. The same bacillus, whether in water or in nutrient broth, failed altogether to penetrate Pasteur filters during the several weeks over which the experiments lasted.

In the instructions for the use of the Berkefeld Field Service Filter, which were printed on linen and issued by the War Department, it was directed that "whenever opportunity occurs the filtering cylinders should be boiled for a few minutes, and this should be done every third day, *if practicable.*" It would appear that the opportunities did not occur, and that such frequent sterilisation was not found practicable.

As to the rapidity of filtration or output of the Berkefeld filter, Dr. P. Frankland, who reported very favourably on this form, but tested it bacterially after too short a time (twenty minutes), using Loch Katrine water, found that the rate, which was at first about seven gallons an hour, had in one hour diminished to about half that amount, and in twenty-four hours continuous running had come almost to a standstill. The matter removed was a dark brown layer of slime of a vegetable or peaty nature, containing also all the bacteria. He published no trial of the filtrate after the first twenty minutes mentioned above. The Manchester town supply gives a coating of thick black mud, one-eighth of an inch in thickness, swarming with bacteria and other organisms. The Pasteur filter with the same water required cleansing once a week, which seems the ordinary time for the Pasteur form when worked under pressure continuously at its full output.

It is found better, however, to employ a plant rather in excess of requirements, and not to work full speed, so as to take advantage of longer intervals for cleaning. The Yeomanry Hospital, in South Africa, for instance, had in continuous use a battery of 1,000 tubes, which was cleaned and tested as to bacterial soundness once a month. In thirteen months' experience no defective joint or tube was found, and no breakage occurred.

If it were possible to subject Berkefeld filters to daily sterilisation, and if the process of cleaning did not remove a layer of filtering substance every time, these filters would furnish a trustworthy protection against water-borne disease. It would even then have to be remembered that the kieselguhr filters have to be handled with considerable care, as they are far more fragile than those made of porcelain, and the slightest flaw would render them quite useless. In this way the renewal of tubes would become a large item of maintenance. There is, further, no certainty that the Berkefeld tubes are always initially sound, owing to the absence of any reliable test other than bacteriological examination, while the process of cleaning inevitably destroys their soundness, and soon renders the filtration insecure. For these reasons, and the impossibility in practice of having the filter tubes sterilised daily, Berkefeld cannot be substituted for Pasteur filtration as a preventive of water-borne disease, and it is unfortunate, in view of the experience in South Africa, that the fact was not earlier discovered.

The Berkefeld Company are now supplying an improved kieselguhr cylinder under the name of "Tubor." The instructions for cleaning are that the cylinder is to be gently brushed with a piece of "loofah," or with a clean brush, "which latter, however, must not be too hard;" further, it is said—"to sterilise the filtering cylinders (which in hot weather should be done twice a week), the cylinders, after being cleansed or brushed, are placed in a clean vessel with cold or tepid water, and then boiled for an hour." Dr. Andrew Wilson reports that, tried with *B. typhosus* and *B. coli*, the cylinders gave germ-free water for at least four or five days, and must then be cleaned and sterilised, and that they are less fragile than the old form. I have not had an opportunity of testing them.

The "Aeri-Filtre-Mallié" is another similar form, made originally of a fired paste of very finely-divided asbestos. This had little coherence, and in the specimens examined by Drs. Woodhead and Wood was impracticably slow in filtration. The composition has since been changed, the asbestos being now used as only a minor constituent, and in this form there are no published data for estimating its bacterial efficiency.

In case of a suspicion of failure of a filter from any cause, a sample of the filtered water, carefully collected in a sterilised bottle, should be submitted to an expert for bacteriological examination. Whatever form of filter be adopted, the filtrate must of course be carefully guarded from subsequent pollution.

In India, the use of the Pasteur-Chamberland batteries for large supplies has greatly extended since, after the application of a small installation at the schools at Darjiling, the dysentery which had prevailed amongst the pupils disappeared (*Lancet*, August 15th, 1896). Those constructed for the Darjiling municipal waterworks are of the pressure type, and consist of thirty-eight cells of tough cast-iron, coated with an acid-resisting composition, and arranged in four rows. Each cell contains 250 Pasteur filter tubes fixed into solid elastic bushes, and is connected by wrought iron pipes to cast-iron mains, which deliver into cast-iron collecting mains, all protected by the acid-resisting composition. The cells are fitted with gun-metal valves, enabling any one cell or group of cells to be cut out for cleaning or other reason. The inlet and outlet pipes are controlled by sluice-valves in the ordinary way, and by means of a small air compressor the soundness of each cell or any group of cells, with their individual filter tubes, can be immediately tested. It appears that the minutest invisible flaw can be detected in this way, since such would readily permit the passage of air under a pressure of from 10 lbs. to 15 lbs. per square inch, while owing to the peculiar property of the medium (when soaked with water) of which the Pasteur tubes are composed, no air could escape if they were sound. All the parts of the installation are interchangeable, and its nominal output is 150,000 gallons per day.

Similar cells are largely used in this and smaller sizes by some of the larger steamship companies for sterilising the drinking water. The filtration of ships' water is of considerable importance, as many ports of call are known to have inferior water supplies.

For military or travelling purposes, exhaust filters are found by experience more suitable than the pressure forms, as they involve no joints which have to be loosened for cleaning. During the last Ashanti expedition, a number of portable pressure filters were used in the field, and caused trouble in this way. They were constructed of aluminium alloy, with gun-metal fittings, with the object of reducing the weight to the utmost extent consistent with serviceable strength. The station where they were used was the only one which did not suffer from dysentery, so that the efficiency of the filtration was thus again verified.

Exhaust filters are made for personal use, with single tubes which can be readily cleaned, or with batteries for the use of bodies of men. In view of the temptations offered by casual streams to men on the march, small pocket filters in a case, which could be used with or without a small hand force-pump can be supplied to the men. Mouth-suction filters are always objectionable, as it is hardly possible to prevent the saliva passing down the tube. The siphon form is useful if a suitable vessel is at hand, but the portable form with hand pump is much to be preferred. A small air-chamber should be introduced to make the action of the pump regular.

The reports of the French Minister of War in 1889 and 1892 demonstrated that a conspicuous diminution in the number of deaths from typhoid in the French army had followed the substitution of spring or filtered water for the water of rivers or wells. In the barracks at Melun, in 1889, the deaths from this disease had been 122; after the introduction of the Pasteur-Chamberland filter, the mortality of subsequent years fell to 15, 6, 2, 7, and 7. In one case the attacks were confined to soldiers lodged in the better rooms, who had made use of water from troughs fed from the Seine, on account of the filter being frozen. The other battalions, who had drank nothing but the regimental tea, had not a single case. Similar and quite as conclusive examples occur throughout the report in reference to typhoid and cholera, and still more striking instances are given in the report of 1894. This uniform experience extended over 250,000 localities in different climates during eight years.

The slowness sometimes urged against this class of filter arises from the attempt to get a higher duty than the nature of the water allows, therefore the size and the number of tubes must be proportionally regulated. Where slimy matter is present and power is available, a mechanical system of brushing might be employed; better still, in some cases, would be a preliminary straining through coarse sand, with a Pasteur filter as a final steriliser.

In conclusion, although there is no doubt of the utility of properly-managed sand filtration, where possible, as a first line of defence, it is known to be liable to breakdowns, as in the Altona example in 1894, when a fresh outbreak of cholera occurred through one of the sand filters becoming deranged through freezing. Dr. Klein has proved the repeated presence of sewage organisms in the London sand-filtered supplies, and Dr. Shirley Murphy showed cause for connecting fluctuations of typhoid in London with imperfect filtration. In my own laboratory I have examined these waters for *B. enteritidis sporogenes*, a typical and pathogenic form, and, although the test was negative with the ordinary small quantities, the organism was detected in the deposit removed by a Pasteur candle from about 50 litres. The filter passed 53½ litres of water in 120 hours, and the deposit was then diffused in 18 c.c. of the water, divided as follows, and examined for the presence of spores:—

2·5 c.c. = 7·45 litres of the original water.
2·0 c c. = 5·96 ,, ,, ,, ,,
1·0 c.c. = 2 98 ,, ,, ,, ,,
0·5 c.c. = 1·49 ,, ,, ,, ,,

Cultures of *B. enteritidis sporogenes* were obtained from all the fractions down to and including 2·98 litres; those below, corresponding to 1·49 litres gave negative results. I have also repeatedly found *B. coli*. I also isolated the same organism from the deposit of a Berkefeld filter attached to the rising main of a house in Cadogan-square, when making an examination of water supplied by the Chelsea Waterworks, with Dr. Parkes, in 1898. (Parkes and Rideal, "Public Health," 1899). Another constant danger is the contamination of the water in its passage to the consumer, from the liability of pipes, even under pressure, to suck in polluting matter from the soil, so that it has been frequently demonstrated that the supply to houses is often much inferior to the filtered water in the reservoirs and large pipes. A second line of defence, such as that of domestic filtration, is therefore necessary. Some years ago I pointed out that as this sterilisation was essential for absolute safety, much of the expense might be saved by making the preliminary treatment at the works less costly, as it was clearly superfluous to purify water required for a large number of common uses. It becomes a question whether we should aim at the whole public supply being purified up to the maximum standard of a good drinking water, or whether we should be content with a somewhat less purified water for the general supply, and sterilise separately in each house, under some conditions of municipal control, such portions as would be required for food purposes. It is probable that a gallon a head per day of sterilised water would be sufficient for drinking and for culinary use, so that only from 2 to 5 per cent. of the total supply would need to be hygienically perfect. Filtration on a smaller scale is sometimes the only purification practicable, but, in any case, it is necessary that the method adopted for the household drinking supply should be an efficient one. The required apparatus should be furnished as an integral portion of the ordinary water fittings, and the duty of keeping it cleansed and in order would be secured by official inspection. The expense would bear no comparison with the outlay periodically occasioned in combating diseases which are conveyed through the medium of impure water. It ought to be possible for the water companies to better their position with the public by letting out purifying apparatus on a rental, like gas fittings, possibly including attendance as well, and in cases where the water supply is under municipal control, such a safeguard would be more economical than going further afield for a new unpolluted source when such a step is not imperative from inadequacy of quantity.

The methods of purification already discussed have been mainly directed towards the *elimination* of bacteria from water. A better solution of the problem is to bring about their destruction. This can be accomplished in two ways, either by bringing the water to a temperature capable of killing the organisms, or by introducing a chemical re-agent effecting the same end.

Miscellaneous.

THE APPLICATION OF SCIENCE TO INDUSTRY.

The report of the special sub-committee of the London Technical Education Board on the application of science to industry, which was under discussion at the meeting of the London County Council last week, contains much matter of interest in the reference to the loss of business in various branches of British industry, and the most feasible means of combating any further diminution. The sub-committee consisted of Mr. H. J. Powell (chairman), Mr. A. A. Allen, Mr. Bousfield, Mrs. Bryant, the Rev. R. S. de Courcey Laffan, Mr. W. Leaf, Sir Philip Magnus, Mr. T. A. Organ, Sir Owen Roberts, Mr. F. W. Verney, Mr. Graham Wallas, Mr. H. Ward, Mr. Sidney Webb, Mr. C. A. Kohn, and Dr. Garnett. The witnesses were Mr. J. W. Swan, F.R.S., Sir Bernhard Samuelson, F.R.S., Sir Henry Roscoe, F.R.S., Dr. Frank Clowes, Professor James Dewar, F.R.S., Dr. J. T. Merz, Dr. W. H. Perkin, F.R.S., Professor S. W. Ramsay. F.R.S., Mr. Thos. Tyrer, Professor Meldola, F.R.S., Mr. George Beilby, Dr. T. E. Thorpe, C.B., F.R.S., Professor W. E. Ayrton, F.R.S., Professor H. E. Armstrong, F.R.S., Mr. J. Levinstein, Mr. Alex. Siemens, Mr. Herbert Jackson, Mr. Hugh Bell, Principal Sir Arthur Rücker, F.R S., Mr. A. G. Green, and Dr. Gordon Parker. Written reports have also been received from Professor M. J. M. Hill, F.R.S., Professor Cormack, Professor Fleming, F.R.S., Professor Lunge, and Mr. B. S. Rowntree.

Dealing first with the question of the loss of business, the committee state that they were unable to resist the conclusion that various branches of industry had during the past twenty or thirty years been lost to this country owing to the competition of foreign countries, and that in many others our manufacturers had fallen seriously behind our foreign rivals; that London in particular has distinctly suffered; and that these losses were to be attributed in no small degree to the superior scientific education provided in foreign countries. They referred to the transfer from England to Germany of numerous departments of manufacturing chemistry. The best known instance of loss was that of the manufacture of aniline dyes and many other valuable products from coal tar. The total exports from Germany of coal tar products now exceeded £4,000,000 annually, of which about one-fourth came to the United Kingdom. The United Kingdom now paid annually over £3,000,000 for imported chemical dye stuffs of one kind or another. As an instance of an industry in danger at the present time, the committee point to what has always been in part a London manufacture, that of pottery, especially of the finer kinds.

Dealing next with the causes of this loss of trade, the committee observe that all witnesses agreed in considering the relative backwardness of this country in scientific industries as due in the main to the deficiencies of our educational system. The glass industry had suffered from the inability of manufacturers to appreciate the value of science, from want of touch with scientific institutions, and especially from the want of an institution similar to the Physical Institute at Charlottenburg. The recently established National Physical Laboratory would, it was hoped, now fulfil this want. That industries were affected by education was perhaps best proved by the vitality of scientific industries in those countries in which the system of secondary education was supplemented by scientific education of University rank, for the perfecting of which no expense was spared. Summing up all the evidence, the committee are convinced that the main causes of our relative failure in the chemical, optical, and electrical industries are—(*a*) The lack of scientific training of the manufacturers themselves, and their consequent inability to recognise the importance of scientific assistance. (*b*) The defective condition of our secondary education, and the consequent lack of sufficiently prepared recruits for advanced technological training. (*c*) The lack of a sufficient supply of young men who have been trained in scientific principles and methods, and in the application of science to particular industrial processes. (*d*) The lack of any institution providing advanced technological training, which is sufficiently endowed to enable it to give adequate attention to post-graduate or advanced work.

With regard to science training in the secondary school, the committee state that scientific industries have suffered in England, not only through defects in higher scientific training, but to an even greater extent through defects in general and secondary education. They add, "In the majority of secondary schools the curriculum has been so hampered by the exigencies of examining authorities and of examinations, that the teacher has been compelled to devote undue attention to storing the minds of the students with facts for reproduction at the expense of the time which should be devoted to stimulating their reflective powers, and making them think. In after life, those who enter upon industrial pursuits too often regard science with distrust, and to some extent this distrust is merited, owing to the insufficient preparation and training of those who offer themselves for responsible posts in scientific industries."

Proceeding to deal with the question of science instruction at the University, the committee state that they have been impressed with the need for providing increased opportunities for the young chemist, electrician, and engineer. Part of this provision was being made in the evening work of the Polytechnics from which a number of students annually took the degree of B.Sc. at the University of London; but there was a consensus of opinion that the highest grade of technical education must be carried on in an institution of University rank open during the day. The existing institutions of University rank in London were hampered by deficient endowment, deficient accommodation, deficient teaching power, deficient equipment, and by the deficient preparatory training of the students. The improvement of equipment and the strengthening of the teaching staffs could be effected partly by co-ordination and partly by securing to the institutions a moderate increase in their income from a reliable source.

Dealing with the development of advanced technology in London, the committee express the opinion that the greatest need of London at the present time is the co-ordination of the provision for the highest grade of education and the development of new departments, so that professors of the highest distinction and practical training should have under their supervision post-graduate or other advanced students carrying out research work. The committee urge that the education of a leader of a scientific industry should include (1) a good general education on the classical or modern side of a secondary school up to the age of 17 or 18; (2) three years' training for the B.Sc. degree, followed by (3) two years' "post-graduate" work in order to obtain the D.Sc.

Concluding their report with a review of the work and prospects of the Technical Education Board, the committee state that the expenditure required to put London in a position to equip itself as well as, say, Berlin, is altogether beyond the range of the sums with which the County Council has entrusted the Technical Education Board, and even beyond the amount which it could legally spend on technical education. They were specially impressed by the need of higher salaries being provided for science teachers alike in the secondary schools and University colleges, by the desirability of lowering the fees at the University colleges, and by the importance of extending the scholarship ladder in respect of exceptional students to a later age than was at present customary. They did not, however, feel able in the present financial position of the Board to press any specific recommendations. The cause of the want of vitality in our scientific industries was not far to seek; it was due to defects in secondary education and the lack of adequate provision for training and research. If secondary education could be more widely extended; if general and scientific education, both in secondary schools and schools of University standing, could be made more thorough; and if further opportunities could be provided to enable post-graduate and advanced students to obtain adequate training in technological research, there was no reason to fear for the future prosperity of our scientific industries.—*Times.*

MINING IN CHINA.

The only mines in China that are worked on modern methods are the coalmines at Tongshan and Lingsi, belonging to the Chinese Engineering and Mining Company. About two-thirds of the work is done by contract, the company paying the contractors so much a day. The contractor employs the miners by the day, and pays them from fourpence to sixpence for eight hours work. Besides their wages, the miners obtain a certain part of the net profits of the contractor. Children below sixteen are not employed unless they are unusually strong and well developed, in which case they are taken as apprentices, and are paid fourpence a day. In addition to the contract work, the Chinese Engineering and Mining Company employs a large staff of miners, coolies, masons, carpenters, overseers, and deputies, besides about one hundred boys who look after the ventilating doors. The number of hours of work, the rates of remuneration, &c., are as follows:—In the mines, about 1,000 men are engaged daily in three shifts of eight hours each. Two thousand men are employed by the contractors in mining coal and doing stonework. The contract rates for mining are about sixpence per ton for dust coal, and fifteen pence for lump coal. A day's work in the mine is divided into three shifts. Coal is mined during two shifts, from 6 a.m. to 10 p.m. The men make from 10s. 6d. to 25s. per month, skilled masons and carpenters receive two pounds ten shillings. In the mines of the provinces of Shansi, Shantung, Feng-tien, Hunan, Szechuen, Yunnan, and Kyas-chau, the primitive Chinese method of mining is employed, and generally the miners are paid on shares. The usual rate is about one-third of the product to the miners, and the remaining two-thirds to the owners of the mines. An entirely different system of paying the miners was adopted by the Mo-ho Gold Mining Company, whose extensive mining rights were situated between Mongolia and Asiatic Russia, embracing hundreds of square miles of rich alluvial and placer deposits. For the successful exploiting of this vast mineral wealth, it was necessary to overcome the tremendous obstacles arising from distance, severity of climate, and total lack of labour. To settle the latter question, it was resolved by the company to inaugurate a *regime* which would induce the labouring classes of Shantung and Chihli to try their fortunes in the Mo-ho Eldorado. The company offered a complete outfit to every able-bodied man, besides advancing a substantial sum for travelling and other expenses incidental to the journey from Tientsin or Chefoo to Mo-ho. Upon arrival, each miner was assigned a large area for his exclusive exploitation. Stations were established at different points throughout the whole region, guarded and protected by the military police furnished by the Chinese Government. Ostensibly the miner enjoyed the entire product of his labour, and the company exercised no control over his mining operations, provided he kept within his allotted area. It was stipulated, however, that the miner should sell all his dust to the company, at a price fixed by the latter, and obtain all supplies from the company's stores. By this arrangement the company was able to recoup the original outlay, which was very heavy, and the miner was given an incentive to work. Many of the miners, after the first two years, became rich, while on various occasions the company declared an annual dividend of 150 per cent. Up to the Boxer uprising of 1900, the Mo-ho Gold Mining Company was the most profitable mining enterprise in China, but since the Russians have acquired control of this territory, all mining operations have ceased.

THE ART INDUSTRIES OF HAMBURG.

In an important commercial city like Hamburg, where the interests of trade and shipping reign supreme, and demand so much of the time and attention of the large majority of the inhabitants, it is not to be expected that art industries can, upon the whole, develop at a very rapid rate. At the same time there are certain braaches of art industry which, precisely owing to these conditions, have found a specially favourable sphere for their production in Hamburg, for the increasing wealth of the inhabitants and their desire to spend a portion of that wealth in beautifying the interiors of their dwellings, as well as the growing custom of erecting and fitting up all public buildings in a decorative style, and also of furnishing and decorating the interiors of the large ocean-going steamers with luxurious taste, have, of late years, given an important impetus towards the execution of artistc industrial work at Hamburg. Whilst in certain branches of art industry, *e.g.*, in the production of artistic furniture, in wood carving, in the manufacture of artistic wall papers, earthenware goods, such as stoves, vases, tiles, &c., and of forged ironwork, Hamburg artists are considered to have given numerous proofs of equal taste and ability with those in other parts of Germany, the two specialities in which industrial art at Hamburg excels, are artistic leather work and glass mosaic. The following summary enumerates the various branches of art industry which are at present carried on at Hamburg, though some have not yet attained to any great importance, viz. :—1. Artistic furniture, inlaid woodwork and wood carving. 2. Artistic metal work, gold and silversmiths' work and jewellery, medals, bronze work (lamps, candelabra, &c.), forged ironwork (pavilions, greenhouses, gates, railings, &c). 3. Artistic leather work and bookbinding. 4. Basket work (chiefly from Japanese models). 5. Ceramic work (earthenware stoves, vases, tiles), glass mosaic, &c. 6. Artistic textile work; embroidery, artistic weaving, &c. 7. Artistic wall papers and wall decorations. 8. Decorative painting of the interior of all kinds of buildings, steamers, &c. 9. Artistic printing and lithography. 10. Drawings of designs for the above art industries. It may be added that an excellent idea of the capabilities of Hamburg art industry may be obtained by visiting the fine city hall in which the larger portion of the fitting up and decoration of the interior is the work of Hamburg artists, and certainly does the latter very great credit.

General Notes.

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The Late Raja of Kotaha.—In the obituary notice of the late Raja Saiyid Muhammad Bakir Ali Khan, C.I.E., of Kotaha and Pandrawal, it was stated that he was a nephew of Mir Muhammad Akbar Ali Khan—as a matter of fact the predecessor of the late Raja was his grandfather. The late Raja has been succeeded by his son Raja Syed Mohamad Jafer Ali Khan, who, like his father, is a member of the Society of Arts.

Railway-fare Rebates.—A startling departure in railway working is reported from America. It is announced that the Pennsylvania railroad will pay rebates to passengers on its 20-hour Chicago trains whenever these trains are more than two hours late. If the detention is two hours, and not more than three hours, the rebate will be 2 dols. For the next hour it is 3 dols., and for four hours or more it is 4 dols. It is understood that proportionate rebates will be paid to passengers to and from Pittsburg, Altoona, Harrisburg, and Philadelphia.—*Engineer.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

SHAW PRIZE FOR INDUSTRIAL HYGIENE.

This Prize, under the conditions laid down by the Testator (Mr. Benjamin Shaw), is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

The Committee to whom the duty of awarding the Prize was entrusted by the Council have awarded a Gold Medal, or a Prize of £20, to James Tonge, jun., 149, Church-street, Westhoughton, Lancashire, for his Hydraulic Mining Cartridge—an appliance for breaking down coal in mines without the use of explosives.

The Committee are well aware that it has been frequently proposed to use some kind of hydraulic apparatus for this purpose, and they have had brought to their notice instances in which such apparatus has been successfully tried. They are not, however, aware of any hydraulic device similar to that of Mr. Tonge, nor that any hydraulic device has been brought into permanent or regular use for the purpose of coal mining, whereas they have had evidence that Mr. Tonge's Hydraulic Cartridge has been used with success in several mines where it has superseded the use of explosives. They have therefore awarded the Prize to this invention.

Forty-three applications for the Prize were received.

"OWEN JONES" PRIZE.

This competition was instituted, in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Board of Education, South Kensington.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates :—

Gray, Naomi S., Polytechnic School of Art, Battersea. Design for an Embroidered Bed-spread.

Eyre, Amy, Polytechnic School of Art, Battersea. Designs for Printed Muslin.

Jarvis, Sarah C. V., Polytechnic School of Art, Battersea. Design for Printed Muslin.

Eadie, Kate M., Municipal School of Science and Art, Birmingham. Design for an Incised and Stained Wood Screen.

Smith, Charles, School of Art, Technical College, Bradford. Design for a Stencilled Frieze.

Payne, Bertram, Polytechnic School of Art, Chelsea. Design for a Chimney Piece.

The next award will be made in 1903, when six prizes will be offered for competition.

EXAMINATIONS, 1903.

These Examinations will commence on March 30th, 1903. The following is the Time Table :—

Monday, March 30 (7 to 10 p.m.).

Grade II. : — Arithmetic, German, Portuguese, Précis-writing, Russian, Chinese, Japanese.

Grade I. :—Arithmetic, German, and Type-writing (from 7.30 to 10 p.m.).

Tuesday, March 31 (7 to 10 p.m.).

Grade II. and Music : — Book-keeping, Italian, Spanish, Harmony.

Grade I. :—Handwriting, &c., French.

Wednesday, April 1 (7 to 10 p.m.).

Grade II. and Music :—English, French, Commercial Geography, Type-writing (from 7.30 to 10 p.m.), Rudiments of Music (7 to 9 p.m.).

Grade I. :—Book-keeping.

Thursday, April 2 (7 to 10 p.m.).

Grade II. :—Economics, Danish, Shorthand (from 7.30 to 10 p.m.).

Grade I. :—Shorthand (from 7.30 to 10 p.m.), Commercial History and Geography.

In the general Examinations (Grade II.), First, Second, and Third-class Certificates will be granted in each subject.

In the Preliminary Examinations (Grade I.), Certificates will be given in each of the subjects enumerated. These will be of one class only.

In Rudiments of Music Higher and Elementary Certificates are given. In Harmony Higher, Intermediate, and Elementary Certificates will be granted.

Certificates of proficiency will be granted in each Grade to Candidates who pass in certain specified subjects during a given period.

A Fee of 2s. 6d. will be required by the Society from each Candidate in each subject in Grade II., and in Grade I. a fee of 2s. for one subject, and 1s. for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Grade II.

Vivâ voce Examinations in French, German, and Spanish are held at any date, at any of the Society's examination centres, where the local Committee undertakes to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate, for not less than 24 candidates.

A Practical Examination in Vocal and Instrumental Music will be held in London, commencing on the 22nd of June. In this Examination special fees are required.

A Society's Bronze Medal will be awarded to the candidate obtaining the highest marks in the First Class in each subject in the General Examinations (Grade II.), and in Harmony, if certified as proficient by the Examiner. These medals will only be awarded to natural born British subjects.

In any subject for which 100 candidates present themselves a second medal will be given. When there are 500 candidates in any subject a third medal will be given. For every additional 500 candidates another medal will be given.

A Society's Bronze Medal will be awarded to any candidate who passes with distinguished merit in the Vocal or Instrumental Examination in Music.

The Clothworkers' Company offer First, Second, and Third Prizes of £5, £3, and £2 respectively in each of the following subjects :—Italian, Spanish, Portuguese.

The Council of the Society offer a First Prize of £3, and a Second Prize of £2, in each of the other subjects, viz. :—Arithmetic, English, Book-keeping, Commercial Geography, Shorthand, Type-writing, Economics, Précis-writing, French, German, Russian, Danish, Chinese, Japanese, Harmony.

The prizes will only be awarded to candidates (natural born British subjects) who have taken First-class Certificates, and are certified as proficient by the Examiner in each subject.

The Council have accepted the offer of a scholarship made by the London School of Economics and Political Science for the most successful candidate in Economics. It will entitle the scholar to a course of training in Economics or Political Science, extending over three years, and to free admission to all the lectures, &c., arranged at the school during that period.

The Examinations are under the control of Local Committees, a list of which will be found in the Programme.

Copies of the programme for 1903, with full details, together with the questions for 1902, and reports by the Examiners, can be had, price 3d., on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

The questions for the years 1896 to 1902 inclusive can also be obtained (price 3d. each year) on application as above.

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The following is the list of the Indian Section as appointed by the Council :—

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Proceedings of the Society.

CANTOR LECTURES.

THE PURIFICATION AND STERILISATION OF WATER.

By Dr. Rideal, F.I.C.

Lecture IV.—Delivered February 3, 1902.

Sterilisation by Heat.

During the last few years several proposals have been made to effect the sterilisation of drinking water by heat. Boiling is of course an efficient means on a small scale, but the expense is prohibitive when large quantities of water have to be regularly dealt with. In India the Larymore boiler has been largely used and found efficient, but the taste of boiled water is often objected to, as such water not only is flat and free from dissolved gases, but has frequently a burnt flavour from overheated organic matter. A successful heat-steriliser must, therefore, be so designed as not only to yield a water which is bacterially pure, but to insure the preservation of the natural flavour and gases of the water, and further some means of regenerating the heat required for effecting the sterilisation must be included. One of the earliest methods for carrying out this object consisted in heating the water to a temperature of about 240° F. in a closed vessel, when the natural gases are not evolved, nor are the salts deposited to any considerable extent, and using the outgoing water for warming that entering the boiler by means of interchanging coils. In such a system the heated water is not exposed to the air, and is therefore kept free from any subsequent contamination. At Brest, in 1892, apparatus on these lines by Rouart and Geneste Herscher and Cie. were officially tested. Later, Professor Vaillard of the Pasteur Institute in Paris, and Mons. Desmaroux devised similar plant, so arranged that all the water passed through a superheater in which it was subjected to a minimum temperature of 235° F. for about five minutes. Connected with the superheater was a temperature exchanger made of a double series of spiral compartments, which cooled the sterilised water to within a few degrees of the supply.

In France this apparatus has been used at the Sanatorium de St. Trojan, in Paris. When made on a large scale, the economy in fuel is greater, and at Tsaritzine on the Volga, a large installation is heated from a common source, and there produces enough sterilised water for a population of 10,000. A difficulty in all such apparatus, however, is met with in the deposition of salts from hard waters in the temperature exchanger, and as, for perfect cooling, the tubes or compartments must necessarily be small, considerable danger is run of such tubes blocking with the deposit, unless facilities for frequently cleaning the tubes are provided. More recently the heat sterilisation of water has been effected in plant in which the water is not heated under pressure, but is brought to the boil, and at once passes over a weir into a temperature-exchanger. In such an arrangement, as the water only boils for a few seconds, it retains most of its original gas and taste, and the apparatus can be so constructed that it is impossible for any water which has not been boiled to pass into the cooler. The Forbes apparatus is designed on these lines. (U.S. patent, December 13th, 1898.) A constant level in the tank placed above the exchanger is insured by a float-actuated valve which maintains the water level in the boiler slightly below a cup placed therein. The valve-box therefore regulates the flow of the water irrespective of the pressure on the surface, in a similar manner to the bird-fountain or aerostatic feed-apparatus used when a constant level is required with a small volume of water. The steriliser operates at a rate which will be dependent upon the size and intensity of the flame of the burner, as the water will boil over the cup at different rates. It is of course obvious that although the rate therefore in a given apparatus depends entirely upon the rate of boiling, or the heat applied, the temperature of the sterilised water will correspondingly vary if the same cooler be always used. The United States War Department has this apparatus in the field, and I am informed that nearly a thousand army sterilisers are at present in use. The army type is made of copper and brass, block tin-lined and nickel-plated. Its nett weight is 55 lbs., and weight in field case 100 lbs. Its capacity with a strong flame produced by a Swedish petroleum lamp is 25 gallons per hour, yielding a sterilised overflowing water 12 degrees higher than the raw inflowing water, but when worked at a slower rate, this difference of temperature may be reduced to only a few degrees. The oil tank provided in the outfit and fitted to the lamp holds 1·37 gallons, which is sufficient to operate the apparatus for 15 hours. At present this steriliser has never been made of a larger size, but it would seem quite practicable to build it in any size even to the extent of sterilising the water supply of a city or town. The larger the steriliser, the more economical it is to operate, and it is stated that it would be possible to sterilise water on the large scale at a cost of from 13s. 9d. to 14s. per million gallons, including interest on the plant, fuel and labour. In such apparatus in America, 1 lb. of coal has sterilised from 2,000 to 5,000 lbs. of water. The principles involved in this steriliser may be summarised as follows :—

(1.) A source of water supply having a level maintained below that required for causing the water to pass entirely through the apparatus.

(2.) The application of heat to a part of the water in the apparatus at the point reached by gravity (due to the maintained level in the source of supply) until ebullition is produced, thereby causing the water to rise and pass through the remainder of the apparatus ; and

(3.) The transference of the heat from the hot water passing from, to the cold water passing to, the point where the heat is applied. In the United States other sterilisers, known as the "Kny-Scheerev" and Maignen are in use ; and in the Argentine Republic a design, due to Von Siemens, has been tried.

In this country the Lawrence steriliser has been in use for some time at Guy's Hospital and elsewhere, and accomplishes the sterilising of the water in a somewhat different manner from that adopted in the Forbes apparatus. The principal idea involved in this plant is a specially-constructed boiling vessel, which consists of a vertical cylinder, in which are placed depositing trays of iron above the water line, and a series of plates termed "locators," in the boiling water. The water to be treated passes down this column, and is met by the steam produced below. The water is thus progressively heated until it attains the highest temperature, and the most violent ebullition, in the lowest compartment of the boiling chamber. In this cylinder the gases are driven off from the water and the carbonates of lime and magnesia deposited as a scale upon the trays and locators, which are removed from time to time, and either replaced in the larger plant by new plates or cleaned. The scale is very friable, and can easily be detached. A small amount of sludge usually collects at the bottom of the vessel, and can be removed from time to time, but causes no trouble as the greater proportion of the lime salts is deposited in the cylinder on the trays. The water thus treated finds its way up on the outer side of the cylinder, and passes to an interchanger similar in construction to that used in other forms of steriliser, where the boiling hot soft water gives up its heat to the crude water and finally issues at any desired temperature, depending upon the rate of boiling. The heat required to soften the water is in this way nearly all recovered, and as a softening plant it has the advantage of requiring but slight attention and of the absence of trouble with re-agents. This plant, when used for softening boiler-feed water, of course does not then require so perfect a heat-interchanger, as it is found best to cool the water back to only 30° above the temperature of the incoming water, in order to avoid the loss by radiation involved in storing or transferring hot water. As already mentioned, organic matter is removed to an appreciable extent whenever softening of a water takes place, so that sterilisation by heat, besides killing bacteria, generally renders the liquid organically purer. In common with the Forbes pattern, the rate of flow depends upon the heat applied, rather than on the amount of incoming water, but it is obvious that in this apparatus without special provision, unsterilised water can pass through into the heat chamber, and so contaminate the supply. By inserting in the boiler a metal plate fitted to a carefully adjusted valve, the steam produced in the boiler can be made to regulate the flow of the water, so that to a certain extent the apparatus can be made as automatic as the Forbes plant.

A portable water steriliser and softener for military purposes on these lines is now being tested for use in the British army.

The boiling vessel consists of an outer case of galvanised iron, about 16½ in. by 6½ in., by 32 in. high, having an opening at the bottom into which is slid an intensive oil lamp with three burners having a great heating power; this chamber is ventilated by holes punched all round, and also by three flues passing right through the centre of the vessel. The upper part contains an inner vessel holding four trays, beneath which are three cylinders each containing a set of "locator" plates having an opening down the centre which enables them to be passed over the three flues; the water on reaching the bottom, passes up outside the three cylinders, and is taken off at the proper level into the heat interchanger.

The heat-interchanger is a galvanised iron box, 20 in. by 6½ in. by 30 in. high. It contains three corrugated cylinders of hard rolled copper connected into a collecting box at both top and bottom; the outlet pipe which is brought up to the top to ensure the vessel being always full of water is fixed inside the tank in order to make it as compact as possible.

This apparatus is designed to treat a maximum of 50 gallons of water per hour working with petroleum, and its weight—about 1¼ cwt.—can be carried on a mule's back. It is proposed to use collapsible tanks to feed and to receive the sterilised water from this machine.

The results obtained in working different forms of heat sterilisers in my own laboratory, show that even with very varying rates of flow, sterile water can with care be usually ensured. At the same time, it must be noticed that with rapid working the amount of dissolved gases present in the treated water is much less than is required to saturate the water at the particular temperature at which it is delivered. If the water is stored for any length of time, in receptacles protected from the air by cotton wool, the cooled water will acquire again its theoretical amount of dissolved oxygen, and then be palatable. This, however, is not possible when the water is required for use at once as in army work. A few years ago M. Maiche devised a somewhat similar heat steriliser which in its army form weighed 278 lbs., and yielded 22 gallons per hour. Major Macpherson, however, considers it too bulky for field service. (*Public Health*, June, 1901.)

The principal objection to heat sterilisers at present seems to be due to the danger of the interchanger blocking up when used with dirty or hard waters, and in army service the difficulty of providing fuel in some campaigns must seriously militate against their general adoption. It is evident that with any system of heat sterilisation in which no interchanger for reducing the fuel consumption is included, as in the recent suggestion of Dr Leigh Canny, not only the cost, but the difficulty of supplying the fuel required must render the system prohibitive. Further, heat sterilisers of non-pressure types clearly do not ensure the destruction of spores, and therefore can only be used as a precaution against cholera and typhoid, and other non-spore-bearing pathogenic organisms. It is fortunate that these two diseases are amenable to prevention by the simpler forms that I have been describing. With candle filters it is clear that theoretically the transport problem is reduced to a minimum, as there is no expenditure of any material during the period of use, so that the weight required is simply determined by the actual filter itself and necessary accessories. On the other hand, for small units and individual troopers, when away from their base, the weight of even a small pocket filter is considerable, and the advantage then lies in some form of chemical sterilisation, to which I must now refer.

CHEMICAL PURIFICATION.

Chemical sterilisation is mainly to be regarded as an emergency method. The considerable total expense for even the cheapest chemical, apart from the labour and trouble involved, must necessarily render the operations costly. Under special circumstances, however, a resort to chemical sterilisers may become useful and even necessary.

Oxidising agents have generally been favoured on the ground that oxygen was the natural purifier, but we have seen that oxidation is only a part, and not the most essential one, of natural purification. Their great disadvantage is that they are largely consumed by easily oxidisable substances which may be physiologically harmless, before an excess can be established to act on bacteria; hence the water must be prepared beforehand by removal of most of the organic matter. The variations in the amount recorded as necessary by different observers is due in great part to this cause.

It is obvious that for drinking water only such reagents are available as do not affect its wholesomeness or palatability. In water supplies, however, from which the greater part of the organic matter has been removed by some preliminary process, the quantity of some oxidising agents required is so exceedingly small that it would have no injurious effect on the consumer. Among these substances the manganates and permanganates have long been popular. Potassium permanganate was employed on a large scale by Lereboullet for the drinking water of the soldiers in the Franco-German war of 1870; at that time it was not a question of destroying the organisms, but solely the organic matter present. In India it has been widely used for purifying wells and tanks, these being regularly "pinked" by officials as a defence against cholera,—Hankin considering it to be a specific for cholera bacilli (*Brit. Med. Jour.*, March 16th, 1895); recent reports on the efficiency of the practice have, however, been unfavourable. Its action on bacteria has been examined by numerous observers. Koch (*Mitth. Kais. Ges.*, 1881) states that it is effective only in concentrated solutions. Calvert (*Brit. Med. Jour.*, March 16th, 1895) found 1 in 125 necessary to prevent growth in *bouillon* for six days. Miquel states that 3·5 grammes were required to sterilise one litre of beef tea, or one in 286. Demarquay, from surgical experience, considered that one in 1,000 "disinfected very well, but its action was rapidly exhausted, and it did not prevent the secretions from retaining their virulence." Vallin was of similar opinion ("Traite des Désinfectants," 1882), also Blyth (*Proc. Roy. Soc.* 1886) and Klein ("Stevenson and Murphy's Hygiene," 1893, p, 61). Dr. A. H. Burgess found that one in 40 was required to destroy *B. coli communis* in one hour (*Lancet*, June, 1900).

I may quote from my own experience an example of the uncertain action of permanganate on organisms in polluted solutions. In July, 1900, I watered two plots of street asphalt under ordinary day conditions with (*a*) ordinary water, (*b*) a 1 in 5,000 solution of permanganate. The liquids running off were collected and bacterially examined. The permanganated sample was almost free from odour, and on keeping for three days smelt much less foul than the other. The cultivation experiments showed the following results:—

		Colonies per c.c.
Gelatine plates, at 22° C.	(*a*)	1,930,000
	(*b*)	85,000
Agar plates, at 37·5° C.	(*a*)	0·001 c.c. gave numerous colonies, and plate was too crowded in 20 hours for counting.
	(*b*)	0·01 c.c. gave a similar result.
Carbolised gelatine plates at 22°C.	(*a*)	122,200
	(*b*)	4,830

Although the permanganate has exercised considerable influence, destroying about 96 per cent. of the bacteria, the result cannot be considered sterilisation, and it will be noticed that its effects upon those growing at blood heat and on carbolised gelatine, which include those of the "coli" group, was similar to that on those growing on the ordinary gelatine plate. I did not specially test in these experiments as to the survival of spores of *B. enteritidis sporogenes*, but from previous work with this organism I believe it to be extremely resistant to permanganate.

Lepeyrère, at the Paris International Congress of Hygiene in 1900, suggested the use of a mixture of potassium permanganate, sodium aluminate, and sodium and calcium carbonates for the purification of water in campaigns. After standing a few minutes the water was passed through "purified peat fibre" mixed with manganese dioxide. The process was examined by Dr. A. Warner (*Public Health*, July, 1901, p. 704) with water infected with *B. typhosus*, and even when filtering slowly did not get rid of the pathogenic bacteria.

Ozone has the exceptional advantage of being easily obtained everywhere from atmospheric oxygen, and recent progress in ozone generators and electric supply lead to the belief that this gas may be economically produced. In several directions it has been used for public supplies on a large scale, and it promises to be further extended as a "finisher" in the sterilisation of water. The chief difference between the action of ozone, O_3, and of atmospheric or ordinary oxygen, O_2, is that the latter will not act on most varieties of organic matter without the help of organisms,—either direct, in their processes of life, or indirect, through a special class of enzymes, called oxydases, that some of them produce. In the sterilising function of ozone only one third of the oxygen actually contained in it ranks as "available" oxygen. The

Chemical.	Effective dose. Parts per 100,000.	Subject of trial.	Time.	Effect.	Observer and reference.	Remarks.
Ozone	9	Anthrax spores	10 min.	Sterile	Ohlmüller, Arbeit. Kais. Gesund, 1892, [viii., p. 229	Ozonised air bubbled through [the liquids
,,	5·8	,, bacilli	,,	,,	,, ,, ,,	
,,	1·95	Typhoid ,,	,,	,,	,, ,, ,,	
,,	1·8	Cholera ,,	,,	,,	,, ,, ,,	
,,	8·4	River Spree water	,,	,,	,, ,, ,,	
,,	15·6	Sewage	1 hour	Not sterilised	,, ,, ,,	
,,	·4 to ·6	Very foul Rhine water, filtered	......	86·5 to 100 per cent. of the samples were sterilised	Van Ermengem, Ann. Inst. Pasteur, 1895, ix., p. 673	
,,	·03 to ·04	Brussels' water supply	5 to 10 min.	All sterilised	Van Ermengem and Gérard's report to Belgian Government, 1897	
,,	1·72	Raw water, 1,250 bacteria per c.c.	......	Sterile	Th. Wehl. Centr. Bakt., 1899, xxvi., p. 15	
,,	·05	Water purified by metallic iron (Anderson)	......	Bacteria reduced 99 per c.c.	,, ,, ,,	
Peroxide of hydrogen	10	Polluted water	24 hours	Usually sufficient to sterilise	Van Tromp, Apoth. Zeit., 1890, p. 485	
,,	100	Cholera and typhoid bacilli	,,	Bacilli destroyed	Altehoefer, Centr. Bakt., 1890, viii, p. 129	
Chlorine	4·	Water	......	Growth of bacteria suppressed	Bucholtz, Archiv. Exp. Path., iv., p. 1-80	Added as chlorine water
,,	20		......	Sterile	Mean of several observers	,, ,
Hypochlorous acid	·3 to ·36 available Cl	Effluents	......	Bacteria reduced from innumerable to 10–50 per c.c.	Kanthack, 1898	Added as electrolysed brine
,,	1·77 ,,	,,	14 min.	Sterilised	Rideal, 1898	,, ,,
,,	40 ,,	Typhoid and cholera bacilli	5 min.	Sterile	Nissen, Zeit. f. Hyg , viii., 1890	Added as chloride of lime
,,	17 ,,	,, ,,	2 hours	,,	Bolton	,, ,,
,,	300 ,,	,, ,,	,,	,,	Boyce, J. Soc. Chem. Ind., May, 1896	Added as chloros (sod. hypochlorite
,,	50 ,,	Non-sporing bacteria	5 min.	,,	Klein, *Lancet*, Nov. 28th, 1896	,, ,,
,,	100 ,,	Spore-bearing ,,	1½ hours	,,	,, ,, ,,	,, ,,
,,	2·4 ,,	B. coli communis	15 min.	,,	Thompson Yates Laboratories, Liverpool, *Sanitary Record*, Aug. 24th, 1900	,, ,,
,,	2500 ,,	Anthrax spores	30 min.	,,	Clayton, J. Soc. Chem. Ind., May, 1896	,, ,,
,,	5 to 10 ,,	Street waterings	......	Growths inhibited	Parkes, *Lancet*, Dec. 9th, 1900	,, ,,
Chloride of lime	11·	B. coli communis	1 hour	Sterile	A. H. Burgess, *Lancet*, June 23rd, 1900	Added as alkaline solution
Chlorine peroxide	·08	Spring water	Immediately after	,,	Bergé. Ogier, Report to French Government, 1900	
,,	·3	Seine water, filtered	2 hours	From 192,000 bacteria per c.c. to very few	,, ,, ,,	
,,	2·38	Coli and typhoid	3 hours	Sterile	,, ,, ,,	
Bromine	6·	Water	5 min.	,,	Schumberg, Pharm. Centr., xxxviii. p. 239	Followed by 9·5 parts hypo-sulph. and 4 pts. sod. carb.
Iodine	20·	,,	......	Growth suppressed	Bucholtz, loc. cit.	Added as iodine water
,,	1·	,,	......	Rendering water potable	Allain, Marseilles	,, ,,
Iodine trichloride	100·	Cholera, typhoid, etc.	5 min.	Sterile	Traugott, Zeit. f. Hyg., 1893, p. 427	In aqueous solution
Cuprous chloride	0·5	Elbe water	6 hours	,,	Krohnke, 1893	Mixed with ferrous sulphate, then lime, and sand filtration
Sulphuric acid	50·	Cholera	15 min.	,,	Stutzer, Zeits. f. Hyg., 1893, p. 116	
,,	20	,,	24 hours	,,	,, ,, ,,	
Sodium bisulphate	176 (= 72 H_2SO_4)	Typhoid	15 min.	,,	Parkes and Rideal, 1901	Followed, if necessary, after 15 min. by sod. bicarb.

gas attacks metals, india-rubber, gutta-percha, and wood, and is thereby itself destroyed, hence apparatus for its production, storage, or conveyance, must be constructed of stoneware or glass, or, less advantageously, of protected metal. The air to be ozonised is first freed from dust by cotton wool strainers, then dried, to avoid the formation of nitric acid, and passed through a cooled space traversed by a silent electrical discharge. Sparks should be avoided, as heat re-converts ozone into ordinary oxygen. Below 6° C. no ozone appears to be formed, from this point the yield increases up to 24° C., then declines. M. Chassy has recently (*Compt. Rendus*, xx. 789) established that the law of increase is the same whatever the intensity of the current, and that the quantity produced tends towards a limit depending solely on the temperature. To obtain a strength of 7 per cent. (the highest mentioned) was found to cost in electric energy 90 times as much as half per cent., so that if economy be considered, it is best only feebly to enrich the oxygen, while accelerating the circulation of gas.

Ozonisers are of a number of forms. Andreoli's has a large number of serrated strips of tinned iron arranged parallel to one another so as to form gratings on opposite sides of plates of glass, and is stated to furnish a larger surface, and a more uniform distribution of the current than the Siemens' type. The gratings are connected with the poles of a dynamo-transformer giving a high-tension current of 10,000 volts. In air passing at a rate of 160 cubic feet a minute about 6 per cent. is ozonised. An experimental water-purifying plant is now being worked with this apparatus at Lea Bridge for the East London Water Company, but I am unable to give any details at present.

Baron Tindal, about 1896, proposed to the municipality of Paris to sterilise, by means of ozone, 5,000 cubic metres (1,100,000 gallons) of crude Seine water daily. His first experiments were made at Oudshoorn, Holland, in 1893. The system was installed experimentally in Paris, Brussels, and Ostend, and was proved by the reports of Dr. Van Ermengem and others to sterilise at a reasonable rate canal and other waters which had been previously filtered. It was adopted officially for limited supplies in several places in France and Belgium. The machines used in the trials at Brussels were Morley-Brush alternators of 100 volts and 100 amperes, with 200 complete periods. The current was sent through a Schneller's transformer, then through a fluid resistance to an apparatus through which a stream of dried air passed at a rate of 40 litres (9 gallons) a minute. The ozonised air, containing 3 to 4·3 grammes of ozone per cubic metre was led into the water at the rate of about 2,400 litres of air to 25,500 litres of water per hour. Prof. Leon Gerard found that "for every gramme of ozone an average of 250 watts was required." He estimated that the gross cost would not exceed 0·45d. or nearly ½d. per 1,000 gallons of water purified, and might be considerably reduced. This does not include the cost of any preliminary treatment which, however, would be necessary under all systems.

In 1898, Siemens and Halske erected an experimental plant at Martinikenfelde, near Berlin, which is still in operation, and has lately been very favourably reported on by Dr. Erlwein (Zeits. f. Elektrochem., Nov. 14th, 1901). As usual, it is found necessary to first remove coarser impurities by a quick filter. The air is ozonised by a Siemens apparatus with one-square-metre plates working with 8,000 to 12,000 volts, and generating 20 to 25 grammes of ozone per horse-power hour, at a concentration of 2½ to 3 grammes per cubic metre. The air then passes upwards through a tower filled with flints, and meets a descending current of water of 10 cubic metres (353 cubic feet) per hour. The original water from the river Spree showed 100,000 to 600,000 organisms per c.c.; the effluent was sometimes sterile, and never contained more than 2 to 9 organisms per c.c. The total cost is estimated at about 2¾d. per 1,000 gallons of water purified, which is much higher than that of Tindal. That the water is not always sterilised may be due to the fact that the ozonisation is less than the amount of 4 grammes per cubic metre which Van Ermengem found to be effective.

Marmier and Abraham's apparatus, installed at Lille in 1898, has a plate ozoniser with cooled electrodes, working with 40,000 volts, and the water is sterilised as above in a masonry tower. The Commission who approved of the apparatus and its results reported that only a few spores of highly resistant and harmless *B. subtilis* were left, and that these disappeared on about 12 hours storage, the water remaining sterile in the air for four days, though showing no trace of ozone a few minutes after issuing from the apparatus. To ascertain whether any antiseptic substance was formed, 373 c.c. of the ozonised water three days old was mixed with 68 c.c. of common water and incubated at 23° C. for six days, when 1,340 organisms per c.c. were found. The Commissioners concluded that "if the greater number of the germs contained in the water were destroyed during the passage through the column, nearly the whole of those which escape this phase of the operation succumb after some minutes in the reservoirs." The only other alterations in the water were a decrease in the organic matter and an improvement in physical character. At Moscow, Russia, an experimental apparatus of this kind was installed in 1901 for purifying the water supply at a stated cost of 0·3d. per 1,000 gallons.

Froelich, about 1890, proved that ozone destroyed micro-organisms, and that its action was most effective in presence of moisture. He showed (Electrotechn. Zeit., xxvi., 1891) that ozonisation sterilises water, oxidises nitrites and sulphuretted hydrogen, and throws down iron as ferric hydroxide, and made the important suggestion that ozone should follow filtration. About the same time Kowalowski and Krukowitsch, in Russia, and Christmas in Paris, investigated its bactericidal power. Ohlmuller, in 1892 (Arbeit. Kais. Gesund., viii., 229), found that water from the River Spree was sterilised in 10 minutes by 86·6 milligrammes of ozone per litre; sewage was not sterilised in an hour by 156·3 milligrammes; but distilled water to which bacteria in great numbers had been added, was sterilised most easily, anthrax, typhoid, and cholera bacilli being killed in 2 to 10 minutes, proving that where water was not too contaminated with organic impurities, ozone destroyed completely these pathogenic bacteria. Ransome and Foulerton in 1901 (*Proc. Roy. Soc.*, vol. lxviii., Feb. 14th) even succeeded in killing bacteria in milk. Other results are summarised in the Table (p. 759).

Hydrogen Peroxide.—The liquid H_2O_2 is similar in action to ozone, breaking up into water and an atom of free active oxygen; it is in fact believed to be produced in the ozonisation of water, and may account for the long continuance of the sterility which we have seen the Commissioners at Lille observed. Angus Smith in 1869, Miquel, and later Paul Bert and Reynard (Berlin Ber., xv., p. 1585) placed it in the first class of disinfectants, and Traugott proved it innocuous to animals. Paneth ("Chem. Centr.," 1890, 174) found that it was a violent poison to many of the lower forms of animal life. All ciliate infusoria—we have shown that some of them cause occasional bad odours and tastes in water—were killed by one of H_2O_2 in 10,000. The results of Van Tromp and Altehoefer are given in the Table. The latter recommended its application for household use as a protective measure in epidemics of typhoid or cholera. But the balance of recent researches have proved that one in 1,000 is necessary, and its cost and instability, the impurities of the commercial article, and the difficulties of transport of large quantities of a liquid, have prevented its use for sterilising water.

Sodium Peroxide is a powerful oxidising agent which generates H_2O_2 when dissolved, and being a solid, is free from the above objection. It has for some time engaged my attention as a steriliser for water, and I have made a series of laboratory experiments on its use, either alone or in addition to the usual softening agents such as soda or lime. It has the advantage over these, of giving rise in the water to an oxidising body which has a specific germicidal effect on the bacteria present. Where the hardness is moderate, sodium peroxide can be used alone, and then has the dual function of precipitating the lime and magnesia together with, as we have seen, a large proportion of the organisms and organic matter, and of inhibiting or killing by means of the hydrogen peroxide produced, any bacteria remaining. In hard waters the hydrogen peroxide required for sterilisation is less than the amount produced from the quantity of sodium peroxide that would be necessary for softening, and it is, therefore, more economical to admix the reagent with cheap softeners not possessing specific germicidal power. As by combination with softening so much of the organic matter is removed, the action of the hydrogen peroxide on the bacteria is better ensured. With the same object, where the organic matter is high, partial softening by ordinary methods can precede the addition of sodium peroxide. This process has the further advantage that the final effect is only a slight addition to the natural sodium salts, and that acid moorland waters are neutralised and bleached, and their plumbo-solvency removed. Appended are two examples of satisfactory results that I have lately obtained:—

A. London tap-water, containing an average of 30 organisms per c.c.; permanent hardness 3·71 parts per 100,000. To separate quantities were added (1) 3 parts per

100,000 caustic soda, (2) 3 parts per 100,000 of sodium peroxide.

B. Somewhat impure water, containing 93 organisms per c.c.; permanent hardness about 4 parts. (1) 3 parts per 100,000 of caustic soda, (2) 1·5 caustic and 1·5 sodium peroxide.

Blanks were mounted in each case, and all the waters after the first shaking were allowed to settle, in series A at about 10°C., in series B at 18°. The number of organisms per c.c. were as follows:—

	A.			B.		
Hours.	Blank.	(1.)	(2.)	Blank.	(1.)	(2.)
1·	31	28	11	115	94	62
3½	27	18	1	103	100	34
24	19	16	0	173	117	2

(1) Shows the result of softening alone, (2) that of softening with the aid of sodium peroxide. The multiplication of organisms in B (1) at the higher temperature is in accordance with what we have previously noticed in simple softening.

Lime alone is slightly antiseptic, as was shown by Liborius, Vallin, and Pettenkofer; later, its action on typhoid and dysenteric discharges was studied by Kitasato and Pfuhl, Richard, and Chantemesse, but in all these experiments the quantity was considerable, 400 parts per 100,000. This is more than would dissolve. I have found that saturated lime water, containing 143 parts of slaked lime per 100,000, apparently killed *typhosus* in half an hour. Burlureaux, by adding it in decreasing quantities to polluted waters, concluded that lime alone could not sterilise without rendering the water unpotable. He believed that the organisms were ordinarily "stupefied," not killed, and this was afterwards verified by P. Frankland, Kruger, and others who noticed the subsequent re-multiplication.

The Halogens.—Chlorine, bromine, and iodine, and their compounds, are amongst the most powerful of germicides. As a rule, they cause oxidation by combining with the hydrogen of water, and liberating oxygen in the "nascent" state, while they also have a tendency to replace hydrogen in organic or other substances containing it, or to form additive compounds. In consequence of the combined actions they (1) deodorise the gases of putrefaction, sulphuretted hydrogen, phosphuretted hydrogen, ammonia, and compound ammonias; (2) lessen, by bleaching, the colour of water; (3) decompose ptomaines and other organic matters; (4) form antiseptic substances nimical to bacteria, but in small quantities nnocuous to higher life; (5) precipitate the albuminoids, therefore attack the bodies of organisms themselves. In many of these actions light is necessary, and heat is also favourable. As with nearly all chemical sterilisers, unless the water first undergoes a partial purification, the great part of the reagent is wasted in attacking comparatively inert matters. Krönig and Paul in 1897 found that the disinfecting power of the series Cl, Br, I, decreases in the ratio of increasing atomic weights, 35·4, 80, 127, but that it varied with the kind of organism and the conditions.

Chlorine water is not convenient to use, on account of its instability, its strong odour and corrosiveness, and its small content of chlorine, 0·63 per cent. by weight. This has led to the employment in preference of the *Hypochlorites* derived from hypochlorous acid, HClO. In commerce they always contain chlorides, which are practically inert; the "available chlorine" being that portion which liberates oxygen on reaction with water; an excess of lime or soda has always been present for the sake of stability, but I am informed that a pure hypochlorite of soda has recently been obtained. These compounds deteriorate when stored, especially in presence of air, moisture, and light, therefore their strength must be controlled by analysis. In "chloride of lime," the available chlorine is expected to be 33 to 34 per cent.; in "chloros" solution, a sodium hypochlorite, it is regulated to 10 per cent. The former, although the cheapest, is generally unsuitable for waters, as it leaves a quantity of insoluble matter, spoils the taste, and increases the hardness. Before 1884, and again in 1887 it was used in the River Thames, but it was shown that "unless large and continuous doses were kept up," the foulness of the stream was not controlled. All hypochlorites in the small quantities that can be used for drinking water, are decomposed by the natural carbonic acid, giving free hypochlorous acid, which in its turn may break up into hydrochloric acid and oxygen.

$$2NaClO + H_2O + CO_2 = Na_2CO_3 + 2HClO$$
$$HClO = HCl + O$$

The carbonate of soda acts in the usual manner as a softener, precipitating carbonate of lime.

Hünermann and Deiter ("Chem. Centr.," 1901, 2 [4], 318), have lately again advocated the use of sodium hypochlorite in the proportion of four parts available chlorine per 100,000, with ten minutes contact; for typhoid and cholera, removing the excess by sodium ulphite. V. Rabs ("Hyg. Rundschau," xi., 085), on the other hand, considers from his xperiments, that with the quantities of chlorine rescribed by earlier investigators the time of ontact must be extended to at least 30 minutes for successful sterilisation.

In the Webster, Hermite, and Electrozone processes, hypochlorous acid is formed by lectrolysis. I have referred in the last lecture o Fuller's results at Ohio with other electrical methods.

The effects of hypochlorous acid are shown n the Table, the variations being explained by different circumstances of time, temperaure, light, acidity, or alkalinity, nature of he substances in solution, and character of he organisms. Although useful as "finishers" or polluted water, the hypochlorites are expensive, and are apt to communicate unpleasant odours and tastes.

Chlorine Peroxide.—ClO_2 is one of the most energetic of sterilisers, and was first used for waters by Bergé. It is prepared by he action of sulphuric acid on potassium chlorate, the resulting gas being passed into water.

$$3KClO_3 + 2H_2SO_4 = KClO_4 + 2KHSO_4 + 2ClO_2 + H_2O.$$

This is easily and safely effected by an apparatus described by M. Howatson.

Although the solution is very fatal to baceria, it is far milder in odour than chlorine or hypochlorous acid, and seems innocuous to animals.

For the same reasons as with previous chemical reagents, to work economically it s necessary to subject the water to a preiminary treatment, which in the Howatson-Bergé process as operated at Brussels and Ostend, consists of softening and mechanical filtration. At the latter place the potassium chlorate used in the preparation is 2 grammes per cubic metre of water, which would give heoretically 0·74 grm. of ClO_2, or 0·74 parts per 100,000. Van Ermengem, in 1898, found hat the canal water, with 890 to 23,000 organisms per c.c., after the treatment n 14 cases was sterile, and in five contained one or two colonies of the resistant and harmess *B. subtilis* or *ramosus*. At Lectoure, in Southern France, the town supply, drawn from he river Gers, and seriously polluted with sewage, has been for many years purified by his process. Dr. Ogier reports that the river water contains 21,000 organisms per c.c. before, and only 7 or 8 after, the treatment with peroxide. Other results are given in the Table. In my own experiments, I found that 2 parts of chlorine peroxide per 100,000 did not kill *B. typhosus* in a vigorous pure culture in 2 hours, but that 5 parts killed it in half-an-hour. These results are comparable with Dr. Ogier's (see Table), but obtained under somewhat different conditions. The slight excess of ClO_2 rapidly disappears from the water.

Bromine has been frequently proposed for sterilising water, the objections being the dangerous properties of liquid bromine, and the taste and physiological action of the bromide produced. In 1897, several practical suggestions were made. Altmann patented a solution of bromine in potassium bromide, using 4 parts Br per 100,000 of water acting for 5 minutes, and removing the excess by ammonia. The solution has the inconvenience of bromine, and is more bulky; the use of a potassium salt has also disadvantages.

Schumberg, of the German army, recommended free bromine, 6 parts per 100,000, for sterilising water in expeditions, on ship-board and in cases of suspicion, stating that sterility was obtained in five minutes. He removed the excess by a tablet of sodium sulphite and mannite, the latter probably to conceal the taste; later sodium thiosulphate and bicarbonate were employed. The method was tried in the Soudan campaign of 1898, but the difficulties of transport of liquid bromine in glass bulbs militated against its use. In the same year Braithwaite proposed to avoid this by adopting a solid mixture of a bromide and bromate followed by acid sulphate of soda to liberate the bromine, but the method does not seem to have been tried on a large scale. The quantity he recommended was sufficient to give one grain of bromine per quart, or 5·7 parts per 100,000, practically the same as Schumberg used. In my own experiments I have found that two parts of Br per 100,000 kills *B. typhosus* in less than half an hour. Schüder (Zeits. f. Hyg., xxxvii., 306) has come to the conclusion that Schumberg's process fails almost completely in the quantities suggested by him, and therefore agrees with the opinion expressed by Dr. Parkes and myself in our paper in Jan. 1901. The fact, moreover, that there must necessarily remain in the water a residue of bromides which are known to have a marked physiological effect, cannot be considered either natural or safe, and should preclude the recommendation of bromine for sterilisation of water for drinking. A similar remark applies to iodine (which was used for the same purpose by Allain at

Marseilles), to iodine trichloride and cuprous chloride, which I have mentioned in the Table, and to many other compounds that have at various times been proposed. My own experiments with iodine trichloride showed that with two parts per 100,000 *B. typhosus* was alive after 20 hours, but that five parts killed it in half-an-hour.

STERILISATION BY ACIDS.

Long before there was any evidence as to the germ theory of disease, the mineral acids had a high reputation as remedial agents. Nitric acid, for example, was used in 1780 by Dr. J. C. Smith for fumigation during a violent outbreak of typhoid in the British Fleet. (Rideal, "Disinfection," p. 87). Acid fumigation with hydrochloric acid was introduced by Guyton de Morveau in 1805, and both these acids and sulphuric acid have been included in Pharmacopœias as internal remedies for a very long period. Even in the Middle Ages, it was suggested that putrid waters might be revived with "oil of sulphur" or *aqua vitæ* (*fortis* ?). Koch was the first to announce that the cholera bacillus was affected by acids. Stutzer found that a solution of ·05 per cent. sulphuric acid was fatal to cholera bacilli in fifteen minutes, and showed that 100 kilos of 60° Baumé, sulphuric acid would disinfect 40,000 litres of water at a cost of less than 1d. per 100 gallons of water treated. It was subsequently proved by Dr. Ivanoff that ·04 per cent. of this acid was fatal to cholera bacilli in Berlin sewage, and Kitasato showed that this acid, and also hydrochloric, destroyed cholera germs in a few hours. Kitasato's results with *B. typhosus* in nutrient media, have been summarised by Horrocks in the following Table :—

	Per cents. of reagent.		
	Growth.	Growth restrained	No growth.
Acids—			
Sulphuric acid	0·049	0·065	0·08
Hydrochloric acid	0·1	0·158	0·2
Nitric acid	0·1	0·157	0·2
Sulphurous acid..............	0·09	0·2	0·28
Phosphoric acid.............	0·15	0·224	0·3
Acetic acid	0·2	0·255	0·3
Carbolic acid..................	0·2	0·258	0·3
Formic acid.....................	0·22	0·278	0·34
Oxalic acid	0·23	0·285	0·366
Lactic acid	0·27	0·36	0·4
Tartaric acid Citric acid Malic acid	0·338	0·384	0·476
Tannic acid.....................	1·3	...	1·66
Boric acid	1·5	2 0	2·7

	Per cents. of reagent.		
	Growth.	Growth restrained	No growth.
Alkalies—			
Caustic lime	0·0725	0·0805	0·0966
Caustic potash Caustic soda	0·1	0·14	0·18
Ammonia......................	0·148	0·2	0·3
Lithium carbonate	0 514	0·6	0·666
Potassium carbonate	0·566	0·74	0 81
Barium hydrate	0·65	0·83	1·03
Ammonium carbonate......	0·72	0·845	1·0
Sodium carbonate...........	2·00	2·2	2·47
Salts—			
Potassium iodide	6·66	8 0	9·23
Potassium bromide	8·0	9·23	10·37
Potassium chloride	9·1	10·6	10·2

In these experiments broth and gelatine media were carefully neutralized before adding the substances, then inoculated with typhosus and kept at room temperature, subcultures being taken at 4 or 5, and at 10-15 hours.

Very different results are obtained, however, when water free from organic matter is employed instead of nutrient media. Thus, ·096 per cent. of caustic lime to kill typhoid in strong broth is reduced to ·0074 per cent., or less than one-tenth, when the broth is diluted with 15 times its volume of distilled water. Similarly in *bouillon* containing less than 1 per cent. of peptone, cholera vibrios are killed by ·01 per cent. hydrochloric acid in half an hour, but require four times this quantity in the presence of 2 per cent. of peptone. It would therefore appear that chemical re-agents, whether they possess oxidising properties or not, are more efficient as sterilisers when the water to be treated is comparatively free from organic matter.

My own results with some of these substances in impure water inoculated with varying amounts of typhoid and kept at room temperature are :—

Reagent.	Per cent.	Time (hours).	Result.
Sulphuric acid	·025	20	killed
,, ,,	·030	(*a*) ½	,,
		(*b*) 1	,, (alive at ½-hour)
		(*c*) 20	,, (alive at 1 hour)
,, ,,	·035	½	,,
Sulphurous acid	·030	20	,, (alive at 1 hour)
Caustic soda ...	·050	½	alive

The organic acids, like tartaric, citric, and acetic, also possess this property; and in 1893, the use of tartaric acid for purifying water, in conjunction with a filter, was patented, and its use has recently been suggested in Italy for sterilising salads before consumption. Dr. Christmas, in 1892, showed that citric acid, although fatal to the cholera bacillus when used in the proportion of 8 parts in 10,000, did not destroy the bacillus of typhoid in a less strength than 1 in 1,000. It may be that lemon juice and vinegar, as dietetic adjuncts in salads and uncooked shell fish, have further been extremely useful in minimising the dangers of typhoid derived from such sources. These facts, coupled with the alarming outbreak of enteric fever in South Africa among our troops, induced me, in conjunction with Dr. Parkes (Epidemiological Society, Jan. 18, 1901), in the autumn of 1900, to specially study the effect of dilute acids when added to drinking waters infected with typhoid. We doubted whether filters or boiling apparatus could be made to accompany a rapidly moving column, and thought that it would be possible to find some acid material which would destroy the virulence or inhibit the growth of the *B. typhosus*, whilst not rendering the water unpalatable or injurious to the health of the consumer. It was also necessary that the re-agent should be rapid in its action, and we fixed from 15 to 30 minutes as the maximum time which in practice could be allowed. It was evident that for transport a solid, preferably in the form of tablets, would be the most suitable form. The following experiments show that sodium bisulphate fulfilled all the requirements :—

SERIES I.—750 c.c. of tap water infected with one drop of a twenty-four hour broth culture at 37°C. of *B. typhosus* (J. 1).

Agar plate cultures made with 1 c.c. of mixture, and colonies counted after 48 hours incubation at 37° C.	Results obtained after contact of infected water with acid solution for periods of :—			
	5 mins.	15 mins.	45 mins.	24 hours
Sodium Bisulphate :—				
1 grm. per pint of infected water	B. typh. killed	Sterile	...	...
½ grm. do.	...	Marked reduction	B. typh killed	...
¼ grm. do.	...	...	No reduction	...
Tartaric Acid :—				
20 grains per pt. of infected water......	...	Sterile	...	...
10 grains do. (A)	Marked reduction	3 colonies	...	...
10 grains do. (B)	...	B. typh. killed	Sterile	...
5 grains do.	...	...	No reduction	1 col.
Citric Acid :—				
20 grains per pt. of infected water	...	Sterile	...	...
10 grains do.	Slight reduction	30 cols.	...	...
5 grains do.	...	...	...	No reduction
Nitro-hydrochloric Acid, B. P. dilute :—				
20 minims per pt. of infected water* ...	...	Sterile	...	...
5 minims do.	...	...	...	No reduction
Sulphuric Acid, B. P. dilute :—				
20 minims per pt. of infected water	...	Reduction	B. typh. killed	...
5 minims do.	...	...	...	No reduction

* The acidity of this solution is equal to 4·8 c.c. N/1 Na OH per litre and the corresponding H_2SO_4 solution 5·8.

Subsequent experiments show the superiority of sodium bisulphate over tartaric acid.

SERIES II.—800 c.c. of boiled tap water infected with two drops of a twenty-four hour broth culture of *B. typhosus* at 37° C.

Agar plate cultures made with 0·2 c.c. of the mixture.	Results obtained after contact of infected water with acid solution for periods of :—	
	5 mins.	15 mins.
Sodium Bisulphate :—		
1 gramme per pt. of infected water	6 cols.	B. typh. killed
Tartaric Acid :—		
1 gramme per pt. of infected water	120 cols.	50 cols.

SERIES III.—100 c.c. of boiled tap water infected with 1 c.c. (approximately 20 drops) of a twenty-four hour broth culture of *B. typhosus* at 37° C.

Sub-cultures made into broth tubes (incubated for forty-eight hours) by three platinum wire loopfuls, after contact of infected water with acid solution for periods of—

	7½ mins.	15 mins.	30 mins.	45 mins.	60 mins.	2 hours.
Sodium Bisulphate :						
1 grm. per pt. of infected water ...	+	+	+	—	...	...
0·75 grm. do. ..	...	...	+	+	±*	...
0·5 grm. do. ...	...	...	...	+	+	+
Tartaric Acid :—						
1 grm. per pt. of infected water ...	+	+	+	+	...	...
0·75 grm. do. ...	...	...	+	+	+	...
0·5 grm. do. ...	...	...	...	+	+	+
Sulphuric Acid, dilute B. P. :—						
20 minims per pt. of infected water ...	+	+	+	+	...	...
15 minims do. ...	...	...	+	+	+	...
10 minims do. ...	...	...	...	+	+	+

From the latter series we gather that when a water is infected by a culture of *B. typhosus*, sodium bisulphate (one gramme per pint of infected water) is then only effective if contact has been made for forty-five minutes. Tartaric and sulphuric acids in similar strengths did not so quickly prevent the subsequent growth of the bacillus.

In the case of tartaric, citric, and nitro-hydrochloric acids, it does not appear that anything less than the maximum B.P. dose per pint of water is efficient to sterilise, if the contact is not to last longer than 15 minutes. Half the maximum dose (10 grains) per pint is inefficient in the case of citric and tartaric acids after 15 minutes contact, whilst the minimum dose (5 grains) per pint of citric acid has no effect after 24 hours contact; and in the case of tartaric acid the minimum dose did not completely sterilise after the same period. Of the two, tartaric acid appears to be the most potent in its destructive action upon *B. typhosus*.

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* Growth after forty-eight hours somewhat inhibited in the sub-culture.

The pint has been taken as a standard, as this is the quantity of water which a man might be expected to drink off at once: one gramme to the pint is equivalent to 1 in 568.

Nitro-hydrochloric appears to be more efficient than sulphuric; but no further experiments were made with these, as it was considered essential that the substance to be carried by individual soldiers in the field should be a solid, and not a liquid.

Acid sodium sulphate is not a B.P. medicinal substance. It probably has no purgative effect, as the astringent properties of its free sulphuric acid would tend to counteract any laxative action of the sodium sulphate. The minimum purgative dose of sodium sulphate is a quarter of an ounce, and in the use of 15 grains per pint of water, a man would have to drink seven pints before a quarter of an ounce of a salt, not known to be purgative, would be taken. Even if this quantity of water was drunk in a day, there is no evidence that a quarter of an ounce of the bisulphate would exert any harmful effect.

Series I. shows that the *B. typhosus* is killed by only five minutes' contact with solution bisulphate in the proportion of one gramme per pint of infected water; but fifteen minutes gives additional security.

As regards acidity, the same amount of acid, as measured by decinormal soda solution, appears to be required to produce a similar result in nitro-hydrochloric acid (dilute B.P.), and sulphuric acid (dilute B.P.), while sodium bisulphate in the proportion of one gramme to the pint contains about two and a half times the acidity of 20 minims of sulphuric acid (dilute B.P.). If anything, the nitro-hydrochloric acid appears to be the most efficient *quâ* acidity; and this is intelligible when it is recollected that there is likely to be a small quantity of free chlorine in this acid. The citric and tartaric acids, to be efficient, must contain at least three times the amount o acid, as measured by decinormal soda solution, that is sufficient for nitro-hydrochloric and sulphuric acids.

Series IV.—500 c.c. of boiled tap water infected with one drop of a twenty-four hour broth culture of *B. typhosus*. Cultures from four different sources were used, marked respectively J 1, R, B, and M, thus making four infected waters. The one marked J 1 was found to contain 9,120 cols. of *B. typhosus* per 1 c.c.

Agar plate cultures made with 1 c.c. of the mixtures.	Results obtained after contact of infected water with acid solution for periods of:—				
	3 mins.	7 mins.	10 mins.	15 mins.	30 mins.
Sodium Bisulphate:					
1 grm. per pt. of infected water, J 1	Numerous, but greatly reduced*	50	3	0	0
do. R.	Very numerous	200	24	0	0
do. B.	Numerous	140	14	0	0
do. M.	Very numerous	200	Plate spoilt	0	0

This series is especially interesting, as it shows that different breeds of the typhoid organism are practically identical in their behaviour. I have since repeated these tests with the same organisms, after sub-culturing for some months in the laboratory, and obtained almost identical results, thus showing what I believe has hitherto not been established, that sub-culturing outside the human body for a long period, as might occur in natural waters, does not sensibly alter the susceptibility of this organism to chemical reagents.

A further experiment was tried with three waters containing a very large number of organisms, and it was found that sodium bisulphate, in the proportion of one gramme per pint, is effective after 15 minutes contact, even for waters containing as many as 52,000 colonies of *B. typhosus* per c.c., and it is extremely unlikely that any drinking waters would be infected with bacilli exceeding in numbers per c.c. this quantity, unless a large quantity of turbid urine from a convalescent case had recently mixed with the water.

Major Macpherson has since pointed out that some of the tablets of sodium bisulphate examined by him were liable to crumble into powder, and that sodium bisulphate is somewhat deliquescent. These two opposite properties are due to mechanical difficulties of manufacture, as I have found that there are varying grades of commercial sodium bisulphate having different physical properties, and quite recently I have pointed out to Messrs. Jeyes and Co. the conditions under which a reliable tablet can be obtained.

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* Greatly reduced when compared with the blank (control experiment).

Dr. Warner (*Public Health*, July 1901) has studied the behaviour of this salt towards other organisms, and finds that as already pointed out (Series III.) with strong solutions, although the number of typhoid organisms is very considerably diminished after 15 minutes, a longer time is necessary for sterilisation, but adds, "a contact of 30 minutes does undoubtedly, in the majority of instances, destroy *B. typhosus* in a tap water under the conditions of the experiment." This author has further pointed out that *B. enteritidis* is also killed by the reagent, and has a resistance very much of the same degree as *B. typhosus*, and that *Sp. choleræ* succumbs far more easily than either of these two organisms, and, therefore, is of the opinion that the salt would affect disinfection of contaminated wells more thoroughly than the permanganate at present in common use in India for the purpose.

Prof. Firth has also made a great number of experiments at Netley, to determine the action of bisulphate on the typhoid bacillus, and has shown that by increasing the dose to 3 grammes per pint, the sterilisation can be obtained in five minutes; and that if the excess of acidity is then objected to, it is easy to neutralise the water by the addition of 2 grams of bicarbonate of soda. I am glad to find that this authority is able to say in *Le Caducée* (Nov. 23rd, 1901) that "Cette méthode parait éminemment pratique pour les besoins du service en campagne;" and further, that "par un emploi judicieux, le bisulfate de soude peut contribuer pour une large part à diminuer les causes d'infection de nature typhique ou cholérique portés par l'eau de boisson." Unfortunately, I am unable this evening to give you any statistics as to the effect of using this salt in South Africa, as the official returns are not yet available, but I may add that the New Zealand contingent were supplied by their Government with this means of water purification early last year, and it will be interesting to study the enteric figures in the official report, as they will give some indication of the practical value of the method, as compared with the other proposals to which I have already drawn your attention.

Miscellaneous.

THE GERMAN GLOVE INDUSTRY.

Germany has of late years greatly increased her facilities in the glove-making industry, and has overshadowed France in quantity of product at least. At the present time, 1,100 German concerns are engaged in this industry, the total output of 85 factories being for export alone. All but 100 of the factories are entirely occupied with the kid glove industry. Germany also has 100 tanneries for kid leather, and over forty for shoe leather. The glove industry is scattered all over the German Empire, Thuringen and the Kingdom of Saxony having the most factories. Other European nations interested in the manufacture of gloves are Austria-Hungary, 350 factories, nearly all at Vienna and Prague; France, 225 factories, with trade headquarters at Paris, Grenoble, and Chaumont; England about 190 factories, situated in London and Worcester; Italy, 100 factories, at Naples, Milan, and Turin; Sweden, 60 concerns, mostly at Stockholm and Malmo: Norway some 50 factories scattered over its land; Spain about the same number; Russia some 25 large concerns, and about 10 smaller, and Belgium with her only important makers (very few in number) at Brussels.

LOBSTER FISHING IN CHILE.

The island of Juan Fernandez, lying 600 miles west of Valparaiso, made famous by the story of Robinson Crusoe, promises soon to develop industrial interests. The island belongs to Chile, and the Government is now arranging to make it a part of one of the provinces, and establish a local Civil Government. The island is about 15 miles long and 8 miles in width. There is a good harbour on one side, where large ships can anchor with safety. A large canning factory has been established on Juan Fernandez, and the fishing industries are attracting the attention of capitalists. There are large quantities of lobsters, crabs, and excellent food fishes in the waters. The lobsters are large, of excellent flavour, and especially suited for canning. They are easily caught, the supply seems inexhaustible, and the cost of securing them is said to be nominal. Consul Mansfield, of Valparaiso, states that there are also large numbers of fur seals on Fernandez and other islands near by, the taking of which might be profitably included in the lobster and fish business. The laws of Chile permit the killing of seals from March 1st to November 1st. There is a ready market for the seal skins at Valparaiso, whence they are shipped to Europe. There is plenty of fresh water on the island; land can be acquired by settlers without cost; fruit and vegetables grow wild, and are easily cultivated, which makes the cost of living comparatively low.

General Notes.

Photography at the St. Louis World's Fair.— Arrangements have been made for a full allowance of space to be set aside in the Palace of the Liberal Arts for photography, and also a certain amount of room in the Palace of Fine Arts. The Palace of the Liberal Arts is one of the big temporary buildings in the Exhibition. In style, the structure is French Renaissance, with an inner cloistered court, after the Italian fashion. The building is to cost 500,000 dols., or about £104,000, and it will cover an area of 400,000 square feet, the façade being 150 feet long. One of the groups on view there will relate to photography in all its bearings, including equipments, all manner of processes, and separate, collective, and comparative results. These include the materials and instruments, as well as the apparatus of photography, equipment of studios; negative and positive photography on glass, paper, wood, cloth, and enamel; photogravure in intaglio and in relief, photocolography, photolithography—stereoscopic prints; enlarged and micrographic photographs; colour photography; direct, indirect, and photo-colour printing, with scientific and other applications of the art. The intention is to include in the scheme, on the architectural side, photographs of public buildings, hospitals, dwellings, with the ornamentation of grounds, parks, &c. Thus, this section will afford the photographer the opportunity of exhibiting sun-pictures of some of the stately homes in the United Kingdom, also of their beautiful surroundings. And in the mechanical side of the art, machinery used in photo-mechanical printing, and the results attained, as specimens of engravings and drawings obtained by, reproduced, enlarged, or reduced by mechanical photographic processes, will be shown. Further, in the Palace of the Fine Arts, the space set aside for the purpose in question will be, among other subjects, for work that may be defined as "distinctive art photography," which may either deal with landscapes or the figure, and also for works produced by photo-engraving processes. All works will be subject to selection by a jury now in course of formation. A grand prize, with gold, silver, and bronze medals, will be awarded, and diplomas issued. Intending competitors should apply to Mr. George F. Parker, the Resident Representative in the United Kingdom of the of the Universal Exposition, St. Louis, 1904, at Sanctuary House, Tothill-street, Westminster, S.W.

Indian and Ceylon Tea.—Messrs. Gow, Wilson, and Stanton in the *Trade Circular*, note that the large areas of land brought under tea cultivation in India and Ceylon during recent years, which are now coming heavily into bearing, have caused a reduction in the value of tea sufficiently serious to threaten the existence of the industry. In 1900, in India, the area of tea in acres was 522,487, the total exports in lbs. was 185,641,303; in 1901, the latter figure dropped to 180,841,237. In Ceylon, the area of tea in acres was, in 1900, 384,000; the total exports in lbs. was 148,431,639; in 1901, 387,000, and exports, 146,310,638. In spite of constantly expanding outlets, consumption has proved unequal to compete with supply even at continually reducing prices. Many estates do not pay at the present time, and unless a change for the better occurs, some properties must eventually go into liquidation. Another feature may prove dangerous to the industry, viz., the possibility of China exporting larger quantities of common tea now that the export tax has been reduced to an *ad valorem* duty, and therefore falls but lightly on low-priced tea, added to which the present low price of silver is all in favour of increased export from China. Until consumption overtakes production, the industry cannot be in a healthy state. To attain this end only two courses are open—the extension of markets, or the curtailment of supply. Extension of markets seems the most feasible remedy, and has so far been attended with distinctly beneficial results, but a far more rapid development is necessary for the well-being of the industry. Now that Ceylon has increased its export tax on tea by 50 per cent., and thus raised its annual funds for developing new outlets from £20,000 to £30,000, there is good ground for hoping that greater efforts will be made, more especially by encouraging the manufacture of green tea. The world's annual consumption of green and uncoloured tea amounts to nearly 90 million pounds. Out of that total, Ceylon, last year, contributed about 1 million pounds, and India, only 70,000 pounds.

Wireless Telegraphy. — The *Westminster Gazette*, on Saturday last, devoted a column and a half to the Armstrong-Orling system of wireless telegraphy. We have referred on two or three occasions to this system, the receiving apparatus of which was described in these columns last December. We now understand that a company is about to be registered to manufacture and supply the transmitters and receivers. It is stated that apparatus has been worked out suitable for wireless signalling up to a dstance of twenty miles, the ground being used as a conductor, and that it will be sold, at a very cheap rate, for private installations. Details of a technical nature are, however, entirely wanting, and without these it is impossible to form any opinion of the system. So far as we know, no description of the transmitter has been published, although we were told eight months ago that it was proposed to read a paper upon it before one of the scientific societies. We have also consulted the patent files, but there is nothing in Mr. Orling's name as yet printed which is specially novel or remarkable. It is therefore advisable to wait until further particulars are available before deciding whether the "programme of amazing promise" sketched in the *Westminster Gazette* is likely to be realised.—*Nature.*

Journal of the Society of Arts,

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FRIDAY, AUGUST 15, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in Prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers, and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the Annual Competition of the Board of Education, South Kensington. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1903, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

SECTIONAL COMMITTEE.

The following is the list of the Colonial Section as appointed by the Council:—

COLONIAL SECTION COMMITTEE.

- Sir William Henry Preece, K.C.B., F.R.S. (Chairman of the Council).
- Sir Charles Malcolm Kennedy, K.C.M.G., C.B. (Chairman of the Committee).
- Earl of Aberdeen, G.C.M.G.
- Lord Belhaven and Stenton.
- Lord Brassey, K.C.B.
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- Hon. Henry Copeland, Agent-General for New South Wales.
- H. Bertram Cox, C.B.
- Edward Dent.
- Rt. Hon. Sir Charles Wentworth Dilke, Bart., M.P.
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- Major-General Sir William Henry Rhodes Green, K.C.S.I., C.B.
- Sir Charles Hartley, K.C.M.G.
- Hon. Sir Robert G. W. Herbert, G.C.B., D.C.L., LL.D.
- Hon. Henry Bruce Lefroy, Agent-General for Western Australia.
- Sir Nevile Lubbock, K.C.M.G., Chairman of the West India Committee.
- Charles Prestwood Lucas, C.B.
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- Alexander Siemens.
- Earl of Stamford.
- General Sir John Stokes, K.C.B.
- Lord Strathcona and Mount Royal, G.C.M.G., LL.D., High Commissioner for the Dominion of Canada.
- Sir Thomas Sutherland, G.C.M.G.
- Hon. Sir David Tennant, K.C.M.G,
- Hon. Sir Horace Tozer, K.C.M.G., Agent-General for Queensland.
- Sir Charles Tupper, Bart., G.C.M.G., C.B.
- Sir Charles Rivers Wilson, G.C.M.G., C.B.
- Hon. Sir Edward Horne Wittenoom, K.C.M.G.
- Sir John Wolfe - Barry. K.C.B., F.R.S.
- Sir James Arundell Youl, K.C.M.G.
- Sir Frederick Young K.C.M.G.
- S. Digby (Secretary).

Proceedings of the Society.

CANTOR LECTURES.

HISTORY OF PERSONAL JEWELLERY FROM PREHISTORIC TIMES.

By Cyril Davenport, F.S.A.

Lecture I.—Delivered February 10, 1902.

My lecture this evening is on necklaces, bracelets, and diadems, all of which may be classed together as large rings. All these ornaments have been largely used by primitive peoples, and are still used by all civilised nations, and they are worn in the same manner as they were originally—namely, next the skin. There has been little or no development among them, except in the case of the diadems, which have developed in a marked degree, from the simple fillet to the enamelled and jewelled crown. Diadems have been used to indicate the wearers' rank from very early times, but the other two, necklaces and bracelets, have more rarely served any purpose other than the ornamental, although, to a small extent, they also have served some utilitarian purpose.

It appears likely that necklaces were the earliest decorations worn by human beings. They were worn long before dress of any kind was thought of or required, and at some times and in some places they are used as symbols of rank.

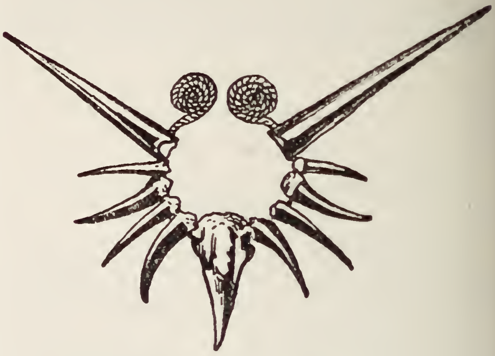
In the Marquesas Islands a necklace of warty-egg cowry shells is a mark of chieftainship, and both in Fiji and the Tonga Islands chiefs wear necklaces of the scarce orange cowry as a badge of their position.

As the feather head-dresses of most savage tribes have their analogues to-day in the full-dress feathered hats of the knights of our great orders of chivalry, civil servants, and of many of our soldiers, so the primitive necklaces are represented officially by the collars worn by the Knights Grand Cross of the great orders, by the chains of office of mayors and civic dignitaries, and the ancient collars of S S still worn by judges and heralds.

The earliest instance of a human skeleton is usually considered to be one which was found by Dr. Rivière, in 1872, in a cave called "La Barma du Cavillon," near Mentone. This skeleton is supposed by Sir Charles Lyell to belong to the Palæolithic age, and in his description of it he mentions the fact that small pierced shells and pierced stags' teeth were found sticking to the bones near the head. These were in all probability the remains of a necklace.

Primitive man, dwelling by preference near the sea-shore, may easily have found material for necklaces or bracelets ready to his hand. Shells like limpets, for instance, are continually found with their crests worn off, at once becoming ring-like beads, and numbers of other small shells are partially worn, by attrition, so as to form pierced rings of more or less symmetrical form. Here is a necklace of shells of this kind, which I picked up the other day at Barricane Bay, in Devonshire, in about ten minutes. Although to pick up and string such natural beads may seem an extremely simple matter, I may remind you that no animal except man is capable of performing unaided this apparently obvious act. Indeed, the first man or woman who found and threaded a naturally-pierced shell or stone, may be truly considered as the first jeweller, for from that first act, all the rest develops naturally. Here also is a small bracelet of other shells and pierced stones I found at the same place. Flints, which are usually formed round some fossil core, are often found in the shape of pierced beads, as the friable core has been worn away by the continual attrition of water. Such naturally-pierced stones have, however, a further value, as they have been considered for a very long time to bring good luck to their wearers.

Fig. 1.



Necklace of Birds' Beaks, from Mashonaland.

Then in time soft objects were purposely pierced so that they could be strung together on a bit of animal sinew or vegetable fibre, easily pierced berries, reeds or eggs gradually giving way to teeth and claws and other trophies of the chase. As knowledge of metals and working in stone grew, so we find more ambitious work undertaken, and materials chosen either for their comparative softness or admired for their beauty, were pressed into the service, shaped as beads, and pierced for stringing together in rows. Amber, ivory, bone, wood, sections of shells wonderfully and patiently made, and finally glass and precious stones, have all been made use of. Gold, silver, and bronze have been made into beads and plaques for necklaces almost from the earliest times in which the metals themselves were used at all.

Although the history of necklaces is largely that of beads, there is another form which is a beautiful one, and was much in vogue over a large area in Europe for a long time. It is that of the Torque, a solid metal ring with more or less ornamental ends, usually twisted, as its name implies, but not invariably so. The finest specimens of ornamental torques are the Greek ones, which have been largely found in or about the Crimea or along the shores of the Black Sea, the best of which are now preserved in the Hermitage Museum at St. Petersburg.

Torques were usually made of gold, silver, or bronze, and often formed an important part of the wealth of their owners, and even appear to have been sometimes used as currency. They have been largely found in France, Great Britain and Ireland, as well as in Greece and Italy. A form of torque with cup-like ends was taken as a model for one of the forms of ring-money. These pieces have the cups large out of proportion to the ring itself, and could not be worn even on the finger. Torques of gold were given as rewards for distinguished military services among the Romans, and on several of the monuments of Roman soldiers the number of torques they had thus received is mentioned. When a torque was itself curled spirally round and round several times it became a "Torquis Brachialis," and was worn on the arm. Both forms are sometimes shewn on sculptures worn simultaneously. Although the torques worn as bracelets have largely survived, forms of them being often discernible at the present day, as necklaces they are quite extinct, the primitive bead form in one or other of its innumerable variations having quite held the field. Solid necklaces like torques to some extent survived as armour or gorgets protecting the neck, and these, again, were now and then decoratively treated; but when jewellery branches off into armour it becomes a different subject altogether, and must be considered separately.

Among bracelets there is little or no constructive sequence of development other than that which I have already mentioned, *i.e.*, the gradual transition from obvious or easily worked materials, to refractory precious stones and metals. I do not know that diamonds have ever been made into beads, but I think all the other precious stones have. Ruby beads are very rare; beads of emerald are well known; sapphires also are rare. Oriental gems have been largely used as beads, and marks of the piercing, or the piercings themselves, can frequently be seen. Oriental beads have often been cut in two for engraving or setting in Western manner, in which case the old piercing will frequently show as a trench or scratch at the back. In the case of the great Cabochon ruby in the imperial crown of Queen Victoria, the piercing is complete, its upper end filled in turn with a small Cabochon ruby set in gold. In the same crown the large pale sapphire from the crown of Charles II., shows the longitudinal piercing.

There are numbers of references to neck-chains or necklaces in the Bible. Among others, when Pharaoh made Joseph ruler over Egypt, he put a gold chain around his neck as a mark of authority (Gen. xlv., 42), and at Belshazzar's feast the king promised "a chain of gold about his neck" to any astrologer or soothsayer who could interpret the writing on the wall. Daniel had the chain given to him when he successfully read the enigma.

In Egypt the necklace of gold was a valued ornament, and even given as a mark of recognition of great services, and was also a mark of an adult. Egyptian necklaces vary largely in styles, scarabæi of various materials usually appear, and at the back was a sort of counterweight called a Ménat. A similar weight appears to have been used by Asiatic peoples, one found at Marathon being kept in the Cabinet des Medailles. They are of porcelain as well as of metal. Large necklaces, with many rows of beads of different shapes, largely cylindrical, are figured on the mummy cases, and they have usually pendants of various gods and emblems cut in hematite, carnelian, or amethyst, or modelled in gold. Numbers of these small pendants are amulets against fancied evils, such as the Ouza, against the evil eye. Many of the Egyptian beads of glass are most skilfully worked in patterns, as are also those of glazed and moulded clay, and are sometimes pierced at both ends so as to string in a series of rows. Small flat discs are common, as well as rectangular forms in glazed clay, and many of the chains have delightful little models cut in stone or moulded in clay, little jackals, cats, frogs, fishes, snakes, bottles, figures of all sorts, alligators, lotus flowers, and innumerable others. Several of the more important of these little images have rings set in the back by which they were suspended, but the majority are simply pierced once or twice for direct threading.

Much of the ornamental gold work is doubly stamped into shape, and then the two pieces are soldered together by their edges. This method was followed at a very early date, as is shown in the beautiful Egyptian necklaces which were found at Dahshur, dating, presumably, from the XII. Dynasty (possibly about 2380 B.C.). These were of gold variously wrought with beads of pearls, lapis-lazuli, emerald, amethyst, and carnelian.

The Egyptians were also skilled in making plaited chains of gold wire, somewhat in the pattern known as "Trichinopoly." To one of these chains, now in the museum at Boulaq, is suspended a large and splendidly-worked scarabeus in gold, which Mariette Bay assigns to the XVIII. Dynasty. The feet are very skilfully soldered on. On another chain of like character are suspended three large golden flies. One chain at Boulaq is remarkable because of the fact that some of the golden beads upon it are partially covered with a transparent blue and red composition much resembling vitreous enamel. It is curious indeed that such skilful goldsmiths and glass-workers as the ancient Egyptians were should never have practised the beautiful art of vitreous enamelling on gold; but the existence of these coloured gold beads shows that they at all events appreciated the lovely colour which could be obtained by means of covering gold with a transparent coloured substance. Enamels of inferior quality were, however, made in Egypt in later times during the Roman occupation.

On some of the Assyrian sculptures necklaces are shown worn by great personages. Sir Henry Layard thinks these were jewelled, but the probability rather seems to be that they were stamped out in thin gold or other metal in the form of flat rosettes or discs, and then strung together. At Rhodes curious beads of thin gold have been found moulded into the form of human faces, and others of glass ornamentally cast in a similar design.

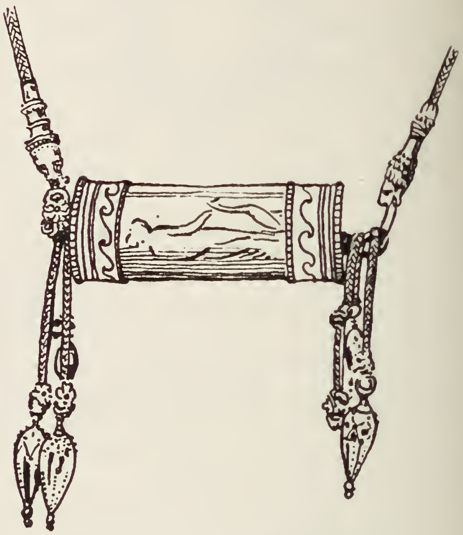
The ancient Greeks and Etruscans were splendid workmen in gold, and numbers of specimens of their skill still fortunately remain for our admiration. In the Island of Milo several fine instances of necklaces have been discovered—one particularly beautiful; one having little lion masks pendant from small chains, with small gold beads, all depending from a master chain. From Athens also come beautiful specimens, as also from the Crimea and other parts of Asia, where Greek merchants settled or traded.

Two of the most interesting discoveries of ancient jewellery have been made by Dr. Henry Schliemann, on the sites of the cities of Mycenæ and of Troy. At Mycenæ were found pierced beads of amber, fluor spar, agate and glass, as well as numbers of beautifully wrought golden beads and small pendants. Many of the ornaments soldered on to flat pieces of gold, were similar to the wire-spirals of filagree work, commonly found in Celtic jewellery. On the site of Troy were found numbers of pierced oval beads of carnelian, and moulded glass beads with coloured markings cleverly made. Numbers of gold beads were also discovered at Troy, some close spirals of wire, and others solid, spherical or cylindrical. Some of silver were found cemented together by chloride of silver, a change probably caused by the infiltration of some salt-laden water. These were still in the form of strings of beads or necklaces, but most of the beads were found separately, the original connecting substance having disappeared by the action of time.

Both at Mycenæ and at Troy numbers of small clay images were found, and on many of these necklaces are clearly shown.

It is probable that the Greek and Etruscan gold work of the 6th to the 3rd centuries (B.C.) is the finest that has yet ever been made. In the later work there is certainly some tendency to over-elaboration of detail, but even here the technical excellence of the workmanship is remarkable. The use of jewels in this work is very sparing, but there are plentiful instances of an effective use of small *cloisonné* enamel work of white, blue and green, always opaque. Fine examples of these beautiful works of art can be seen both in London and Paris, and many of the pieces at St. Petersburg have been very cleverly and carefully copied by M. Giuliano, as well as by M. Castellani, both of whom were highly skilled goldsmiths who made numberless experiments with the object of imitating as closely as possible the ancient granular work. The Etruscans understood the colouring of gold by means of alloys of copper or silver, but did not use it much. On some of the later Etruscan necklaces are found flint arrow-heads beautifully mounted in gold,

FIG. 2.



PENDANT OF ETRUSCAN NECKLACE.

probably considered as mysterious treasures having some occult power.

The vase as a bead or small pendant is common among Egyptian and Assyrian jewellery. So also it is used with great effect by the Greek and Etruscan designers, sometimes simply and sometimes reduplicated into many rows hanging from each other by small chains of gold with rosettes of white or green enamel, and from others depend bullæ or hollow pendants containing relics. Carnelian scarabs and other engraved stones are found in later Etruscan work set in gold edges.

A form of necklace which is characteristic of Græco-Etruscan work consists of a flat plaited band of gold, of varying thicknesses, from which hang festoons of oinochoe or flowers several deep. Fine examples of these were found at Kertch. In other cases the ornamentation of the necklace becomes thicker and deeper as it approaches the front portion. The Greeks used beads of garnet with little gold sockets at each end with admirable effect. These beads are found both spherical and of disc form, and the clasps are often most charmingly wrought into little heads of goats or lions. These pure early styles gradually become debased and more ornate in design.

Pliny says that Roman ladies were accustomed to wear their necklaces of pearls at night, so that they might dream of them. When the necklace consisted of one row only it was called "Linea," when of two rows "Dilinea," and when of three "Trilinea."

A Roman necklace of remarkable workmanship made during the reign of Caracalla in the 3rd century, and now in the Cabinet des Medailles at Paris, has long polygonal beads of gold, between each of which hang alternately a coin or a cameo. These are curiously set in a broad edge of pierced and engraved gold. This necklace is one of the few remaining pieces of ancient jewellery which shows how cameos were worn.

Byzantine necklaces can best be studied from the mosaics at Ravenna and elsewhere; they appear to have been rich and fully jewelled. Reliquaries of all kinds were largely worn during the middle ages, and to a great extent they hung on simple chains, the workmanship of the necklace more or less disappearing before the utilitarian object of supporting the pendant.

Onwards from the 14th century men of rank commonly wore chains round their necks on great occasions, as ornaments or evidences of wealth, but in time the various badges of orders of chivalry were naturally enough suspended from them. These chains were called "colliers," and now we speak of the "collars" worn by the Knights Grand Cross of our greater orders. Gradually, as the knightly orders became more defined in their constitutions and their badges took distinct form, so the links of the chains used for thelr support became accordingly specialised. One of the earliest recorded instances of the bestowal of a chain of this kind by a king in the field of battle is that of Louis XI., when, after the siege of Quesnoy in 1477, having witnessed great gallantry on the part of Raoul de Launoy, he put a golden chain of honour round his neck, and wittily said, "Mon ami, vous êtes trop furieux en un combat, il faut vous enchaîner, car je ne veux point vous perdre."

A "Jaseran" was a sort of coat-of-mail necklace, fastened to each shoulder. They were similar to the gorgets worn as a protection by soldiers, and ladies had these imitated in rich jewelled work, and were duly ridiculed because of it by Rabelais, who speaks of "Les Patenotres, anneaux, Jaserans, Carcans —[another form of a close jewelled necklace]— etaient de fines pierreries, escarboucles, rubis, balais, diamants, saphirs, emeraudes, turquoises, grenats, agates, berils, perles et unions d'excellence."

The chronicle of Jacques Duclerc, in the 15th century, says that French nobles "portaient grosses chaines au col." The Jaserans and Carcans very probably started the idea of jewelled robes, dresses which were at one time largely worn, and must always have been very effective.

Philippe le Bon was noted for his favourite use of black velvet thickly studded with diamonds, and rich examples of the same costly fashion can be seen in numerous portraits of Henry VIII. and Elizabeth, as well as in others of their great contemporaries, both royal and noble.

In France, Italy, and England the jeweller's art in mediæval and later times, as to necklaces, does but reflect in a minor degree the state of decorative art as followed in the more important objects—reliquaries and brooches. Fine work both as to design and workmanship has been done in Spain at all periods.

Putting aside such necklaces as are notable only because of their value—which is unfortunately usually the case with most English modern work—it appears to me that in the truest sense the decorative possibilities of the necklace is best to be found in the work done in India.

Here we find coloured stones and flat diamonds used in such a manner as to show off each other's beauty to perfection, a masterly use of white, green, and red enamels, and an effective arrangement of strings of small pearls and small pierced stones. The brilliant, transparent, crimson enamel of Jeypore has, indeed, been justly celebrated for a long time, and its manufacture was for long kept as a secret; but similar work seems to be now made in other places—indeed, the secret is now divulged, but the brilliant colour can only be obtained with great difficulty, and it requires to be fused on pure gold to have the least chance of success.

There is one historic necklace which deserves notice, because it is, perhaps, more celebrated, and has been more written about and discussed than any other necklace. The story is a discreditable one, but, unfortunately, Queen Marie Antoinette came in for much blame about it, whereas in fact she had nothing at all to do with it, her name having been fraudulently used by an unscrupulous lady of the Court, Jeanne de Luz, Comtesse de la Motte, in order to persuade some jewellers to give up the necklace, which was an ugly festooned collection of large diamonds, valued at "one million eight hundred thousand livres," about £90,000 of our money.

The whole story, with a picture of the necklace, is told in detail by the Abbé Georgel, who was secretary to the Cardinal de Rohan. The cardinal was made into a catspaw by the designing countess, and he fell all the more easily into the trap because there had been some differences between him and the Queen, and he was most anxious to recover his lost ground.

Madame de la Motte persuaded the Cardinal that the Queen much wished to purchase the necklace, but that it was to be done unknown to the King; that the payment would have to be made by instalments, and that the queen would always be most indebted to him if he could manage to secure the jewels for her. The jewellers, Messrs. Boehm and Bassenge, were, like the Cardinal, unsuspicious of any double dealing, and they readily agreed to sell the necklace on the condition of secrecy and payments by instalments. There was a meeting at night, arranged by Madame de La Motte, between the Cardinal and a lady personating the Queen, at which he was assured she wanted the necklace; and this meeting and some false notes, imitated from the Queen's writing by a clever caligraphist, Reteaux de Villette, saying that she wished the purchase, quite satisfied De Rohan that he was acting in every way as the Queen desired.

The Cardinal eventually bought the necklace in the Queen's name, the price to be repaid in four instalments. He showed the jewellers the notes written by Reteaux de Villette, and they, as well as himself, were satisfied that the Queen was a willing purchaser. The necklace was delivered to De Rohan on 1st February, 1785, and he at once took it to Madame de La Motte to hand to the Queen. Instead, however, of doing this, she sent it over to England by a safe hand, where it was immediately pulled to pieces, and the stones sold for as much as they would bring.

Presently, when the first instalment became due, the jeweller, M. Boehm, approached the Queen, and reminded her of her promise. The Queen at once disclaimed all knowledge of the matter, and indignantly informed the King. Unluckily the Royal Family of France was already in disfavour with the people, and an unfortunate belief sprang up that the Queen actually had allowed her name to be used, and that she had gained some profit in the matter. She was evidently entirely innocent, but the incident did much harm to the Royal Family just because it came at the time it did.

The Cardinal de Rohan was arrested, but soon proved his innocence of any fraudulent intention, and was acquitted, but Madame de La Motte was found guilty, and severely punished, as she well deserved. She was branded on the shoulder with a *fleur-de-lys*, and imprisoned for life, but after about a year's imprisonment she escaped in 1787, and went to England, where she amused herself by writing a book of Memoirs in which she gives her version of the story. Her husband also wrote an account of the "Affaire du collier."

BRACELETS.

The bracelet disputes the earlier place with the necklace. There appears to be no savage tribe which does not use some form of one or other of these primitive ornaments, but while the necklace is never of any use, the bracelet sometimes is.

Bracelets are made in many fashions, and of many materials, the main distinction, beyond that of size, between them and necklaces, is that bracelets are more inclined to solidity of structure, whereas necklaces are more inclined to the form of strings of detached beads.

The inhabitants of the Solomon Islands wear large bracelets which act as shields; and among many savage races, armlets and leglets of thick dried skin, having the hair still left on it, are worn, which form valuable protection against an enemy.

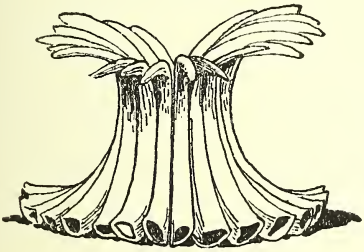
As well as serving as a protection, the bracelet also sometimes plays the part of an offensive weapon. Some of the savages of the Congo carry on their arms heavy iron bracelets, which they use on occasion as projectiles or clubs, and among the negro tribes of the Upper Nile district, spiked bracelets are also used as weapons of war.

The Irenga and the Djibba tribes, both belonging to the district of the Upper Nile, wear a large disc of shell as a bracelet. This disc has a razor-edge, and is normally provided with a leather covering, but is, in fact, a formidable weapon, used in the same way as the Indian warriors use their metal helmet discs. They are thrown with a spin like a quoit, and are capable of cutting a man's head clean off.

The negroes of Lagos use their bracelets as a sheath for a knife or dagger, and the ladies of to-day use leathern bracelets specially designed to hold a watch.

In some parts of Africa the closely wound metal ornaments worn by rich women as armlets and anklets are apt to become over-heated by the sun, and slave girls are told off to keep them cool by continually pouring water over them.

FIG. 3.



BRACELET OF BOARS' TUSKS, FROM HAWAII.

In New Guinea and the neighbouring islands bracelets are made with human jaw bones, and are credited with protective powers, and such as are made with teeth and claws of animals are believed to bring good luck in the chase.

Magicians of all kinds have always been fond of rattling ornaments. Bracelets of this kind are often made with pieces of dried skin sewn into bags, and partly filled with small pieces of bone or pebbles. Similar bracelets are worn during certain savage dances.

It is not only savages, however, that have liked rattling ornaments, as we are told (Isaiah iii. 16-18) that the daughters of Zion wearing anklets "go mincing and making a tinkling with their feet," and Lane mentions an Arab song in which a lover addressing his mistress assures her that "the ringing of thine anklets has deprived me of reason."

When Abraham's servant went to seek a wife for Isaac, and met Rebekah, he gave her, among other things, two bracelets of ten shekels weight of gold, for her hands.

Oriental women sometimes have small chains joining their anklets together, compelling them to walk with short steps and a mincing gait. Livingstone describes seeing an African princess who wore a profusion of iron rings on her ankles, to which were attached small pieces of tin, which tinkled as she walked.

Bracelets now form an important item of the wealth of Hindoo ladies, and they always like them to fit very closely.

During the recent excavations of the Royal Tombs at Abydos, of the 1st Dynasty (4,000 to 6,000 B.C., Lepsius. Mariette), by Professor Flinders Petrie, several pieces of ancient jewellery were found of great beauty and marvellously skilful workmanship, both in hard stones and in gold. In the tomb of King Zer the jewellery that belonged to his Queen was found: four beautiful bracelets of gold, turquoise, amethyst and lapis lazuli being yet on the arm of a mummy, probably that of the Queen, and although this tomb had been examined before, for some reason or other the arm had not been found.

Professor Petrie considers this group of beautiful jewellery to be some two thousand years earlier than the discoveries at Dahshur. The beads were found resting in their original order, so that they could easily be re-strung as before. Some remained still strung on gold wire and cow's hair.

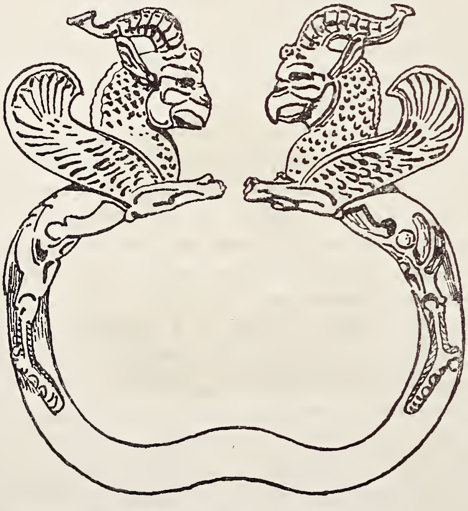
The treasure found at Dahshur belonged, supposedly, to the XII. Dynasty, about 3000 years later than that from Abydos. They were in a brick pyramid, and were discovered by M. J. De Morgan, Directeur Général des Antiquités d'Egypt, in 1894. Among the pieces are the clasp of a necklace (formed of two lotus flowers ornamented with turquoise, lapis lazuli, and carnelian), bracelets of gold and of gold and carnelian beads, several pendants for necklaces of gold, emerald, lapis lazuli, carnelian, and amethyst.

Sir Henry Layard says the Assyrian bracelets had in their centres stars and rosettes, which he thinks were probably inlaid with precious stones. They were more likely all metal. Armlets, bracelets, and anklets were universal ornaments in the East, especially among women; they were also used by princes as insignia of royalty. The bracelet worn on the upper arm indicated the higher rank. Signets were doubtless tied round the wrist or arm; in this way the engraved cylinders of Assyria were probaby worn.

At Mycenæ, Dr. Schliemann found very curious bracelets of gold wire spirals. He also found a magnificent amulet of gold, bearing as a centre ornament a large flower with silver petals. Dr. Schliemann finds signs of copper in these silver plates, and thinks they may have been originally gilded in the copper, as he says the Mycenæans did not know the art of gilding directly as to silver. At Troy, the same discoverer found bracelets of copper, gold, and electrum of plain spiral form, and others with ends like truncated cones. Some were plain, others twisted, and one beautiful pair, of thin gold, with gold wire spirals soldered on all over them.

To some extent, both bracelets and anklets have merged into armour, the close spiral bracelets of bronze or tin found in France or Germany, have ultimately become brassards and leg pieces. Others have retained their decorative character, and reached their most ornate style when the thickened ends were worked into the sphinxes, bulls, lions, an other figures, of which, perhaps, the fine examples were found in the Crimea or on th Oxus, and are mostly to be seen in the Herm tage Museum at St. Petersburg. Bracelets o this kind nearly resemble the torques in desig but, of course, are much smaller. Early Roma gold bracelets are often very solid and heav and it is supposed they may have been, many cases, a form of money. The Roma are considered to have first set metal bracele with precious stones, coins, and engrave gems, but they were usually of metal onl Such, doubtless, were the ornaments envied b Tarpeia—who opened the Roman city gates t the Sabines on condition that they gave he what they carried on their left arms. Tatius the Sabine king, agreed to this, and whe inside the citadel, threw upon the traitress hi golden bracelet and his heavy shield. Hi soldiers following his example, she was quickl crushed to death.

Fig. 4.



Grœco-Bactrian Armlet—found near the River Oxus.

In Homer's Iliad (Il. XVIII., 401) Venus i described as wearing bracelets, probably o the spiral form seen on the painted vases The serpent form was a favourite one amon the Greeks and Romans, and a fine specime of this kind was found at Pompeii.

In the tomb at Koul-oba, supposed to b that of the King and Queen of the Chersones (about the 4th century, B.C.) several beautifu bracelets were found of the torque kind, bu some were of jointed plaques ornamented wit delicate gold work. At Pompeii was found a painting of a young man, probably Adonis wearing necklace, amulets and bracelets an anklets, but all these are probably intended t mark effeminacy. The Greeks had differen names for bracelets according to when the were worn. On the wrist was worn th perikarpia, on the arm above the elbow th peribrachionia, and the same distinction wa made among the Romans, armilla meanin that worn on the wrist, while "brachiale" o "torques brachialis" or "spinter," indicate that worn above the elbow.

In recent times Petitot's enamels were ofte set in bracelets. Under the Directory, whe dress became extravagant, the Merveilleuse wore several bracelets, copied from the antique on each arm.

Under the first Empire, hair bracelets cam into fashion, and also the revived use of cameo in bracelets, and the French jewellers, Meurice Marchand, and Robin, particularly distin guished themselves by their excellent copies o Greek originals. Duron, on the other hand nd his inspiration for the Renaissance, and de beautiful works in gold of different lours, inlaid according to the design, and ished with delicate chasing.

DIADEMS.

The bandeau or fillet tied round the head s probably first used to keep long hair from tting into the eyes of primitive man. resently it became specialised, priests wearing e pattern and fighting men another.

The soft band which can be seen figured on e heads of kings in early coins, is no doubt a ark of chieftainship. This use of a band, of pecial colour, to indicate authority, probably iginated in the East. It was adopted by lexander the Great, who also used the diadem f the King of Persia. Justinian says that lexander's predecessors did not wear any iadem. Justinian also tells us that the iadems then worn were of some soft material, s in describing the accidental wounding of ysimachus by Alexander, he says that the urt was bound up by Alexander *with his own iadem*. This was considered a lucky omen or Sysimachus, who actually did shortly afterwards become King of Thrace.

At Mycenæ, in 1876, Dr. Henry Schliemann ound some beautiful diadems—long, thin, oval old plates, *repoussé*. These were bound round he head by a small gold wire, the holes for vhich are at each extremity. In some cases hese diadems were found actually in the kulls of their wearers ; on others the black shes of the funeral pyre can still be seen. On ome of the terra cotta and marble statuettes of Aphrodite, found at Cyprus, the heads are rnamented with similar diadems. One diadem was found in band form, in which, on the ower edge, are perforations, from which Dr. Schliemann thinks, pendants may have hung.

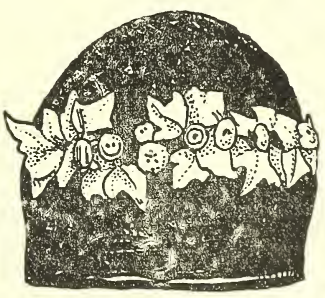
The same discoverer found several beautiful diadems of gold among the supposed ruins of Troy. These were of a different design from the Mycenæan specimens ; they are peculiar in construction, consisting of a flexible flat fillet of small gold links, pendant from which is a close fringe of small chains, the links of which are more or less thickly sown with small, heart-shaped leaves. The side chains are much longer than those over the forehead, and terminate in a curious flat ornament, distantly resembling the conventional human form. Dr. Schliemann thinks these are idols. It appears as if the Trojans were acquainted with the art of wire-drawing, but they often used strips of rectangular section for bracelets and rings, cut off from the edges of sheets of metal, and it is just possible they may have found out some way of rounding such strips by rolling or rubbing them down. Thin gold bands for the head were also found on the site of Troy, ornamented with small *repoussé* designs.

In Egypt diadems of particular shape are of very ancient use. There were crowns for Upper and Lower Egypt, and a combination of both for the whole country. They were also distinguished by colour. The Uraeus or snake worn in the crowns and head-dresses of the Pharaohs was a symbol of royalty. Representations of the Egyptian gods always show them as wearing crowns.

In Assyrian sculptures deities and kings are shown wearing diadems, apparently bands of stuff or leather studded with discs of *repoussé* work. Some of these discs, detached, have actually been found. Similar discs were plentifully found at Mycenæ, which were very likely used in a similar way. Some of the larger ornamental head-dresses worn by Assyrian kings appear to have been conical shaped helmets, or perhaps crowns ; it is now difficult to say which, because the material of which they were made cannot be ascertained. If they were of gold, they were probably crowns, like the wonderful openwork golden Scythian headdress found at Kertch, but if of an inferior metal they may have been only helmets.

At St. Petersburg, there is a beautiful ancient Greek diadem representing a crown of olive. An Etruscan ivy wreath of thin gold still encircling a bronze helmet, is in the British Museum.

FIG. 5.



ETRUSCAN HELMET WITH GOLDEN FILLET.

Justinian says that Morimus tried to hang himself with the diadem, evidently a ribbon-like bandeau, sent to him by Mithridates. The Roman royal diadem was originally a white ribbon, a wreath of laurel was the reward of distinguished citizens, while a circlet of golden leaves was given to successful generals.

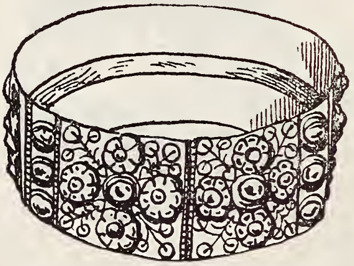
Cæsar consistently refused the royal white diadem which Antony offered him, preferring to remain perpetual dictator. One of his partisans ventured to crown Cæsar's bust with a coronet of laurel tied with royal white ribbon, but the tribunes quickly removed it and heavily punished the perpetrator of the offence.

During the Roman Empire the prejudice against the white bandeau remained strong. The Emperors dared not wear it. Caligula wished to do so, but was dissuaded on being told that such proceeding might cost his life. Eliogabalus used to wear a diadem studded with precious stones, but it is not supposed to have indicated rank, but only to have been a rich lady's parure, this Emperor being fond of dressing himself up as a woman. Caracalla, who took Alexandra the Great as his model as far as possible, is shown on some of his coins wearing a diadem of a double row of pearls, a similar design to which was used by the kings of Parthia. On coins of Diocletian, who shows a double row of pearls, sewn on a double band and tied in a knot at the back.

Both in Greece and Rome ladies of rank habitually wore diadems. There can be seen on many of the chased or *repoussé* mirror cases or on the backs of the metallic mirrors themselves, as well as painted on the black and red vases, and on the small statuettes of terra cotta or bronze.

Diadems gradually closed in and became crowns, and on Byzantine coins highly ornate diadems can be recognised, and there are many beautiful examples of them in enamels and mosaics, as well as a few actual specimens. At Ravenna, in mosaic work in the church of San Vitale, are crowned portraits of Justinian and his Empress Theodosia; in the enamel portrait of the Empress Irene in the Pal d'Oro at Venice, can be seen a beautiful jewelled crown with hinged plaques, and the same construction is used on the iron crown of Lombardy; the sacred crown of Hungary and the crown of Charlemagne, all m beautiful specimens of jewellers' work.

FIG. 6.



THE IRON CROWN OF LOMBARDY.

On the plaques of the crown of Constant Monomachos are also fine enamel portrait himself and his queen Zoë, wearing sim crowns. The cataseistas, or jewelled chai one over each ear and one at the back, wh occur on all these crowns, may be the survi of the loose ends of the tie of the origi fillet.

In later times of Greece and Rome, owing the growth of republican feeling, the diad lost its political significance, and was relega to the ladies. Beautiful specimens of orn mental diadems are now to be seen in Hermitage Museum at St. Petersburg. Th were found about the Crimea, having b probably left there by Greek traders, in change for the produce of the Euxine.

In the middle ages the diadem regain much of its earlier significance, and ceased be only the simple head ornament it h become. Now it became specialised in for reserved as an emblem of rank. The forms royal crowns and diadems is a large and f cinating study, and where original examp do not now exist, the development can often followed in sculpture, coins, or seals. Heral now plays an important part. Diadems circlets gradually give way to closed crow in the case of sovereigns possessing indepe dent authority.

During the reign of Napoleon I. there was France a strong reaction in favour of antiq fashions generally, jewellery not excepted, a no Court lady felt properly appointed unle she included a rich diadem among her tre sures, mounted or thickly set with camec gems, or jewels. The diadem, howeve shortly went again out of fashion.

In England, what with actual losses a purposeful destruction, we have none of o ancient crowns left, but those we have a made nearly in the lines of the older ones. Th existing crowns are none of them earlier tha the time of Charles II., and although th possess a form which, to some extent, is a su vival, they are not otherwise remarkable.

In Scotland is kept a beautiful crow modelled on the lines of one made for Robe Bruce, and said actually to contain much the original gold, and many of the origin jewels; it was also much altered and adde to in the 16th century, by order of James V.

The coronets of our peers date their preser form only from the reign of Charles II.

If the regulations recently promulgated f dress of peeresses at the coronation of ward VII. can be taken as an index, the amental diadem for ladies' wear will again ne into fashion.

diadem, richly jewelled, is, indeed, a very coming addition to a lady's toilette, and it y be hoped that the fashion of wearing it full dress occasions, will really be revived, reby providing a fresh and important field our newer school of designers, as well as the technical resources of our higher class vellers.

An interesting instance of a lady's preference a diadem as compared with a coronet curred at the coronation of Queen Victoria. e rule is that when the crown is put upon sovereign's head, all the persons of lesser gree entitled to do so put their coronets on so. The Duchess of Cambridge, however, uld not displace a very handsome diamond adem she was wearing, so instead of having r coronet placed on her head, it was only ld over it by one of her maids of honour. e circumstance is shewn in Sir George ayler's beautiful picture of Queen Victoria's ronation.

IDES SHOWN IN ILLUSTRATION OF NECKLACES.

1. Necklace of leopard's claws from Natal.

2. Necklace of bird's beaks from Mashonaland, hibi's country.

3. Necklaces of shell discs with plaques of bone d turtle shell from Micronesia.

4. Necklace of human teeth, with seeds and shell cs from the Solomon Islands.

5. Ancient Egyptian necklace, with scarabœi and ads of gold, lapis, and amethyst, and a pendant hæmatite.

6. Ancient Greek necklace, from Carysto, in ubœa, of spherical garnet beads set in gold, with m's-head clasps.

7. Ancient Greek necklace, with an engraved linder of carnelian.

8. Ancient Greek necklace, with small chains and ndant vases, found in Southern Russia.

9. Ancient Greek necklace, with golden heads of , and mottled green beads of glass. Found in the rimea.

10. Ancient Etruscan necklace of glass and metal eads, with two beads showing grotesque human eads.

11. Necklace made by Carlo Giuliano after the truscan manner, with gold beads and granulated ead of Achelous.

12. Egypto-Roman necklace with gold discs and earls, beads of gold and carnelia, and emerald and orcelain pendants,

13. Ancient Roman necklace of amethysts and gold beads, with large gold beads inlaid with coloured composition.

14. Ancient Roman necklace of gold polygonal beads, carrying a *repoussé* medallion with head of Roman Emperor in high relief.

15. Two golden torques, one British the other Irish.

16. Restoration of an ancient British necklace of amber, showing large rectangular plaques joined by rows of small beads.

17. Anglo-Saxon necklace of glass beads and amethysts, with central pendant of millefiori glass, and others of coins of Clothaire II.

18. Italian necklace of the 16th century, of enamels, pearls, and sapphires.

19. Italian necklace of the 16th century, with enamels, rubies, and garnets.

20. French necklace of the 16th century, with enamels, diamonds, and pearls.

21. French necklace of the 17th century, with enamels, garnets, and pearls.

22. French necklace of the 18th century. The "Queen's necklace," made by Messrs. Boehm and Bassenge for Queen Marie Antoinette.

23. Modern necklace from Bengal, with pearls and large lobed diamonds.

24. Modern necklace from Bengal, of four rows of pearls, with pendants enamelled and set with emeralds and diamonds.

25. Modern necklace from Delhi, with enamelled plaques set with diamonds, and having a large pendent set with a large ruby in the centre surrounded by flat diamonds.

SLIDES SHOWN IN ILLUSTRATION OF BRACELETS.

1-4. Ancient Egyptian bead bracelets of the I. Dynasty, lent by Prof. Flinders Petrie, and shown before by himself at the Society of Arts.

5. Bracelet of boar's tusks, from Hawaii.

6. Golden bracelet with silver flower, found by Dr. Henry Schliemann on the site of Mycenæ.

7. Golden bracelets with wire spirals soldered on, found by Dr. Henry Schliemann on the site of Troy.

8. Golden bracelet with two finely modelled gryphons, found near the River Oxus. Græco-Bactrian work.

9. Golden twisted bracelet with two sphinxes *affrontées*. Græco-Scythian work, found at Kertsch.

10. Greek bracelet of gold with fine granulated work.

11. Roman bracelet of gold with open work.

12. Roman snake bracelet of gold.

13. The Koh-i Noor in its original setting as the armlet of Nadir Shah.

14. The golden bracelets made for Charles II. by Sir Robert Vyner. Enamelled with the national badges—Rose, Thistle, Harp, and Fleur-de-lys.

15. Armlet, with a double row of 22 enamelled and jewelled studs. From Bengal.

16. Bracelet, terminating in dragon's heads, with ruby tongues. Set with diamonds, and richly enamelled in white, and the beautiful red of Jeypore. From Jeypore.

SLIDES SHOWN IN ILLUSTRATION OF DIADEMS.

1. Diadem of thin gold, with *repoussé* rosettes. Found on the site of Mycenæ, by Dr. Henry Schliemann.

2. Diadem of golden fringe, with long ear-pieces. Found on the site of Troy, by Dr. Henry Schliemann.

3. Ancient Etruscan golden diadem of ivy leaves still remaining on the bronze helmet of its owner.

4. Ancient Roman diadem of gold, with openwork, pearls, beads, and enamel. Found in the Crimea.

5. The "Corona Ferrea," or Iron Crown of Lombardy, containing the iron rings made from the nails used at the Crucifixion. Now at Monza.

6. The circlet, set with diamonds, made for Mary, of Modena, Queen of James II.

7. Golden helmet or crown of Scythian workmanship, found at Kertch. Openwork finely *repoussé*.

8. The crown of Constantine Monomachos, of seven golden plaques, finely enamelled. Now at Buda-Pest.

9. The "Corona Sancta," or crown of St. Stephen. Byzantine crown, with uncut jewels and enamels. Now at Buda-Pest.

10. The crown of Charlemagne. Eight plates alternately jewelled and enamelled, crossed by a jewelled arch. Now at Vienna.

11. The crown of Scotland, originally made for Robert Bruce, but much added to and altered since. Now at Edinburgh.

12. Queen Victoria's Imperial Crown, made by Rundell and Bridge in 1838, containing the ruby of Edward the Black Prince, the sapphire of Edward the Confessor, and the sapphire from the crown of Charles II.

Miscellaneous.

ST. LOUIS (1904) *EXHIBITION COMPETITION.*

The directorate of the Universal Exposition of St. Louis offer a prize of 2,000 dols. (about £400) for an artistic design for a seal. The emblem or design must symbolise the history of the great Louisiana Territory, and its purchase by the United States from France in 1803—an event deemed only second in importance to the signing of the Declaration of Independence—and it must harmonise with the purposes of the World's Fair, by which the centennial of the purchase will be celebrated. As to form, it is suggested that a circle is the more appropriate shape, but an oblong, an oval, or other usually accepted form, would not put the competitor out of court. If in relief and circular, it must have a diameter of 20 inches; if not circular, it must be of rather larger dimensions; if for a medal, the two sides should be sent; if for a poster, the drawing must be on canvas or carton, 24 inches by 36 inches, with a clear margin, the full size being 28 inches by 42 inches. The design may be mounted or not, but should be without cover, glass, or frame. It is proposed to use the design as the official seal; on the office stationery; for the decoration of articles; possibly for a medal; and also for many other purposes. Colours, if used, are restricted to red, blue, yellow, and white, those of the banners of the three nations—Spain, France, and the United States—under whose sovereignty the territory has been during its history. A jury has been selected to judge the designs, consisting of the Presidents of the National Academy of Design, New York; the National Sculpture Society, New York; the Society of Western Artists, Chicago; the American Institute of Architects, New York; Chapter of American Institute of Architects, Philadelphia; and the Louisiana Historical Society, New Orleans. Designs are to be delivered in New York between November 1st and November 5th, 1902.

LIGHTING BY MEANS OF ALCOHOL.

Although the flame of pure alcohol is not luminous, it may be made so by carburising the spirit with the addition of 35 to 60 per cent. of coal-tar benzine; or the flame of uncarburised alcohol may raise to incandescence a mantle of the rare metals as in incandescent gas-lighting. Hence the two main divisions into which alcohol lamps may be classed—those with free flame from carburised spirit, and those with uncarburised spirit and incandescent mantle.

The lighting exhibits at the Paris Industrial Alcohol Exhibition, were practically divided into three categories, viz.:—(1) Lamps (for lighting streets, stations, works, &c.) of 60 to 800 candle-power, consuming from 1 to 1·6 gramme, one gramme is 1-30 oz. of debased alcohol per candle-power per hour, or of 100 to 1,000 candle-power, consuming from half a gramme to one gramme per candle-power per hour; (2) incandescent lamps of 12 to 50 candle-power for domestic use, consuming from one to three grammes of carburised or uncarburised alcohol per candle-power per hour; and (3) lamps of 8 to 15 candle-power, consuming from 6 to 8 grammes per candle-power per hour. Outside these categories, the jury granted a silver medal to M. Laurent for his application of electricity and use of carburised air to the lighting of incandescent lamp from a distance; and a work of art was awarded to the Société La Washington, of Paris, for its collective exhibits under two of the above-named categories. This company also received a gold medal for its lamp of high power, with two or three mantles and independent reservoir for carburised or uncarburised alcohol.

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FRIDAY, AUGUST 22, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill Prize of £50 and a Silver Medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges no paper deserving the full award is sent in.

SECTIONAL COMMITTEE.

The following is the list of the Applied Art Section as appointed by the Council:—

APPLIED ART SECTION COMMITTEE.

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Sir Thomas Wardle.
Henry B. Wheatley, F.S.A. (Secretary).

Proceedings of the Society.

CANTOR LECTURES.

HISTORY OF PERSONAL JEWELLERY FROM PREHISTORIC TIMES.

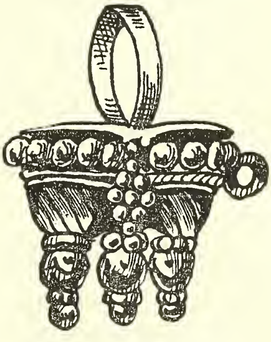
By Cyril Davenport, F.S.A.

Lecture II.—Delivered February 17, 1902.

Nose Rings and Lip Rings.

All savages love ornaments. Sir John Lubbock (Lord Avebury) says that in some of the very lowest races of mankind "the women are almost undecorated, but that is only because the men keep all the ornaments themselves."

Fig. 7.



Indian Toe-Ring.

One of the earliest body ornaments worn by savages is some object, natural or artificially fitted, worn either through the cartilage or the wing of the nose. The natives of the Solomon Islands wear crabs' claws run through the cartilage of their noses.

In the East nose-rings have been worn from very ancient times, and are still used by several of the peoples of the Levant, Africa and India. In the Levant the ornament is more commonly passed through one of the wings of the nose; in India more commonly through the cartilage or septum. Some of these are so long that they hang down over the lips.

Jewish women wore nose-rings, and are mentioned by Isaiah. They were usually worn in the left nostril, and Lane says they were commonly worn by the middle and lower classes of women in Egypt. Lithgow says that the better sort of Egyptian women wear rings of gold and silver through the cartilage of their noses, and that they are copied by the common folk.

In Gambia, in Africa, a great ring worn through the cartilage of the nose is a mark of nobility.

In Mexico, when Ticois was chosen king, his nostrils were pierced, and an emerald inserted in each. In Mexican picture chronicles, the king can usually be distinguished by his pierced nostrils.

The Guineans thrust small horns or teeth through their noses, and so do, or did, the inhabitants of Florida (Lindschoten).

Purchas says the Peruvians wore iron rings in their noses (the province called "Quillacenca" means iron-nose province), a curious instance of topography being indebted to ornament for its nomenclature.

"Nose-rings" take many forms, that of a jewelled stud being very prevalent. These are usually fixed in by means of a small screw-nut.

The wearing of labrets, or ornaments in the lips, is most practised in Central Africa, along the western border of America, among the Esquimaux, and in some parts of India. The labret is a stud or ring, which is usually set in or about the lips about the age of 12 to 15. As time goes on the size of the stud is gradually increased.

These curious ornaments are variously worn in different tribes; sometimes by men, sometimes by women, and sometimes by both. The largest labret is always worn in the middle of the lower lip. If there are any others they are smaller.

Some tribes have even been named for this custom, as the Botokudo, derived from the Portuguese "botoque," a stopper or plug.

Among the shell heaps of the Aleutian Islanders labrets of white marble and shale are plentifully found.

Labretifery seems to have something of the character of a religious rite, and may originally have been practised as one of the trials a savage boy has to go through before he is considered as a full-grown warrior. In this connection it might perhaps be considered with tattooing, and as vigour and endurance are especially the attributes of males it is probable that the wearing of the labret was originally confined to the male sex.

Among the Tlinkit tribe the use of the labret was forbidden to slaves, it was small and of silver, and was worn by girls. After they were married a larger plug was substituted.

Peter Cander, one of Drake's company, was caught by the Brazilians, and said that for every enemy killed they made a hole in their lips. These holes were afterwards filled with a green stone.

The Peruvians wear turquoises and emeralds in the holes in their cheeks. (Maginus.)

The natives of the islands off the Mosquito Coast of Central America cut holes in the lower lips of the boys, and set large plates of turtle shell in the cut to represent a beard.

Purchas says of the upper classes in Mexico that they had their nether lips bored and set with rings of gold and turquoises which sometimes weighed so much that their lips were pulled down so as to leave their teeth bare. Other Mexican labrets were made of obsidian, black or smoky. On some of the Mexican bas-reliefs these labrets can be seen figured.

Another early chronicler of the Mexicans, Sahagun, says that the great lords had their lower lips slit, and semilunes of gold set in them, others wore polished crystals with blue feathers behind them, looking like turquoises, besides many other kinds of coloured stones.

La Perouse, writing in 1786, says of the inhabitants of Lituya Bay, that they have the lower lips pierced and set with a large wooden plug. Young girls have only a needle set in their lips.

In Queen Charlotte's Island, labrets were only worn by women.

Captain Cook describes labrets of shell or bone worn by the hermits of Prince William's Sound and Cook's Inlet. Beads were sometimes strung to the studs.

In the Aleutian Islands, natives adorn their lips with ornaments of glass and shell inserted into slits in the under lip, and parallel with it; and along parts of the north-west coast of America, the native women commonly wear large elliptical discs of wood in their under lips —made larger in the case of wives of chiefs— measuring in some cases, 5 by 3 inches. The practice of labretifery is now universally dying out.

EARRINGS.

The earliest form of earrings is that in which something is laid over the ear, as, for instance, the common children's ornament of two cherries on one stalk. When the idea of piercing a hole in the lobe or upper part of the ear first arose, is not known, but it certainly is of ancient use. Of all the various piercings for ornamental purposes, which human beings have practised upon various parts of their bodies, that in the lobe of the ear appears to be the least offensive, and indeed it is the only one which has been used by civilised nations. The two other piercings of most use, are in either the nose or the lips, both of which are distinctly disfiguring, as indeed some of the larger ear piercings are, but when small, no great harm is done.

Putting aside the more or less monstrous savage earrings or plates, the point of departure for earrings of actual jeweller's work was, in all likelihood, a simple ring passed through the cartilage. From this ring, as time went on, various ornamental forms depended.

On many of the Assyrian sculptures the finest earrings are worn by kings, and smaller ones, rings with amphoræ depending from them, are worn by lesser dignitaries. But as far as I have observed, they are not worn at all by common people, so that it is just possible they may have had some signification of rank.

M. Eugene Fontenay says that several large ornamental plates and discs were worn by women of ancient Greece; the objects which have been considered as earrings of Greek, Etruscan, Rhodian, and Cyprus origin were really only rings to be worn in the hair just in front of the ears, and he also describes other larger ornaments of similar kind as pendants to be worn over the temples—supported, presumably, by a band over the head, or fastened to a plaited tress of hair like those worn to-day in Burmah and Bengal.

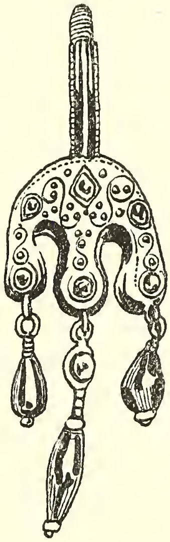
The ancient Egyptians do not appear to have favoured the earring much. According to M. Fontenay, they, however, used the rings for the hair, and he thinks that very likely the earring was only used by the priests. The specimens I have been able to find are late, small, and unimportant, and in form resemble the Greek or Etruscan.

When Moses was building the Tabernacle, the Israelites and their wives brought him their earrings among other jewels.

Chaldean and Phœnician earrings are mostly simple in form, ovals with curved ends, but the Etruscan are of many kinds and beautifully worked. Many of these are made up of thin gold plates, lightly *repoussé*, and enamelled with delicate granular work; others have curious enamelled figures of birds or animals upon them, and small, thin, opaque enamels of white, blue, or green. Among these animals may be found swans, pigeons, peacocks, and cocks; they are made on wire skeletons, and hang by small chains. Small vases are very favourite ornaments, and they are used with admirable effect and taste. Many beautiful specimens were found at Kertch. Some of them have garnets set among the gold. Other Greek earrings show beautiful female heads, rosettes, baskets and vases.

At Pompeii were found some curious earrings in which two pearls were loosely set very near together, so that they made a little ringing or rattling noise at the least movement. There are several specimens in the museum at Naples. One of these earrings is called a "crotalium,"

Fig. 8.



Roman Earring.

Roman earrings are more ornate than the Greek, and not in such good taste. Jewels are more frequent, as well as baroque pearls, and coins are often used as pendants. Some of them are very large.

Merovingian earrings are often set with small flat garnets on the sides of polygons.

In Byzantine times earrings were not largely worn by the better classes, and they very likely had got down to the lower strata of society; but apparently the Empress Theodora wore them, as something shows in her mosaic portrait at Ravenna which may be earrings, but they are so mixed up with jewelled bands depending from the sides of the crown that it is difficult to say for certain.

During the 14th and until the 16th century the fashions of wearing the hair in France were such as to practically cover the ears, so that earrings were not wanted, and even where the ears were not covered the earrings do not appear to have been worn. At Hampton Court is a picture of Henry VIII. and his family, none of them wearing earrings, although they have other jewels in plenty.

Raphael shows the Fornarina as wearing small earrings with little vases.

Marie de Medicis wore earrings of pearls which show in her portraits, and all through the 17th and 18th century the fashion continued in Europe.

Marie Antoinette wore earrings with large oval diamond pendants, and following her example, the peasants of France all wore earrings with large shell pendants.

During the Revolution in France small pieces of the Bastille were made into earrings, and the Incroyables wore earrings; the ladies of the Halle wore them so large that they touched the shoulder.

In the earliest part of the 19th century earrings were largely worn, but their designs were so varied that it is difficult to fix upon any typical form. The best of them were designed on ancient lines, and the later ones are chiefly noticeable by reason only of the value of the precious stones or pearls contained in them.

FINGER RINGS.

I find no constructive sequence or development in the matter of finger rings, so have only used a kind of subject arrangement for my remarks and for my slides. This arrangement is, of course, capable of much subdivision, but as it is, it may be found useful as a table of reference. I make two large divisions, official and personal, and these in their turn are divided as follows:—

I. Official:—

1. Ecclesiastical. — Popes, Bishops, Abbots, &c.
2. Civil.—Coronation rings, masonic rings.
3. Military.—Knights Templars, &c.

II. Personal:—

1. Love and marriage rings.
2. Religious rings—*i.e.*, decade and pilgrim rings.
3. Charm rings—*i.e.*, cramp, talismanic, astrological, or reliquary rings.
4. Mourning rings—*i.e.*, portrait of deceased persons; bit of their hair, &c.
5. Ornamental rings—*i.e.*, signet, giardinetti, precious stones, &c.
6. Miscellaneous—*i.e.*, whistle, puzzle, squirt, poison, watch, compass, &c.

Finger rings, although sometimes found made of bits of curled shell or fibres, are not much used by savage nations. It is obvious that necklaces and bracelets can be worn without interfering with the ordinary work of primitive men, but finger rings are not suitable for anyone using his hands as a workman. So that they may be considered as ornaments chiefly used by persons above the rank of workmen.

Rings with scarab signets are constantly found on Egyptian mummies, sometimes set in gold, and sometimes made of glazed porcelain —glass or earthenware.

There are several references to finger rings as signets, in the Bible. Darius sealed up the lion's den with his signet (Gen. xii. 42), and Jezebel used her husband's seal for the counterfeit letters condemning Naboth (Dan. vi. 17), and for the wearing of rings there are numbers of instances—as when Judith went to meet Holofernes.

Catullus mentions a very early ring legend in his account of the marriage feast of Peleus and Thetis, to which Prometheus came—

> "Sage Promethus, on his hand he wore,
> The slender symbol of his doom of yore
> When fettered fast in adamantine chain,
> Hung from the craggy steep, he groaned in endless pain."

The legend to which this refers is to the effect that Prometheus, having stolen the sacred fire from Phœbus, Jupiter condemned him to be chained to a rock for ever, but in a short time repented the severity of his sentence, and cleverly got out of his difficulty by making Prometheus wear a ring made out of one of the links of his chain and set with a piece of the rock. So that the sentence was actually fulfilled, but the offender was free.

Pieces of the true cross were often inserted in the bezels of rings. The word bezel is a form of the German "bissel," a mouthful, because the chaton, or metal holder for the stone, opens like a mouth to receive it. Relics of the saints, protective substances like the toadstone, and all kinds of talismanic pieces, were set in rings, as well as legends lettered upon them. Many have the names of the Three Kings of Cologne upon them as a charm against disease. These names are

"Gaspar, Melchior, Baltasar," and other words are sometimes added to them. Early Greek rings sometimes have the mystical Swastika upon them.

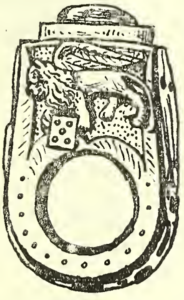
Gyges' ring rendered him invisible when he turned the stone inwards. Many other rings were said to possess this power.

Solomon on one occasion lost his ring, and it was found again at table when a large fish was opened. The same story is told of Polycrates, by Herodotus and there are several other renderings of it.

The Virgin's ring is a superstition to the effect that the wedding ring of Joseph and Mary was of onyx or amethyst, and that it was miraculously multiplied, several examples of it being still preserved among the treasures of churches on the Continent, a particularly fine one in the Duomo at Perugia.

The Doge of Venice used to throw a ring into the Adriatic as a symbol of his marriage to the sea.

FIG. 9.



PAPAL RING.

The Pope's Ring of Investiture is called the "Fisherman's Ring." It is a lesser seal of gold, the Bulla being the great seal. On the stone is engraved a figure of St. Peter in a fisherman's boat with a net. Each Pope has a replica made for him with the addition of his name or initials.

Ordinary Papal rings are very large and cumbersome. They are usually worn outside the glove on the thumb, but if ever worn without the glove they have a smaller guard ring to keep them on. Bishops and Abbots were also invested with official rings, and following their example in this matter, as well as in many of their vestments, Christian kings and queens usually receive a coronation ring on their crowning from the officiating priest. This coronation ring is really a sign of the priestly character of the sovereign. Pliny says the Britons wore rings on their middle fingers.

In Rome as early as the 4th century B.C. solid gold rings were worn. They are also recorded as having been used in the time of Claudius in the 1st century, but they were at this time more frequently made of sulphur or mastic overlaid with thick gold foil.

Several old Roman rings are found with flat metal bezels. It is supposed that these were originally polished, and served as small mirrors. Mirror rings are still used in Hindostan.

Under the early Roman Republic senators alone had the privilege of wearing gold rings, and in the time of Tiberius, in the 1st century, the wearing of such rings became one of the distinctive marks of a knight. When one of these had been invested with the ring he was known as "Eques auratus." During this reign were also promulgated various other sumptuary laws concerning rings, which became, in fact, badges of civil and military rank

No one was allowed to wear a gold ring unless himself, his father, and his grandfather were all freeborn, his property worth at least 400 sestertia (about £4,000), and he possessed the right to sit in one of the fourteen rows of seats allotted to the equestrian order by the Julian law. These laws were enacted to stop the immoderate use of jewellery among the Romans.

The keeping of the Roman Imperial ring was entrusted to a keeper, in the same way as our great seal is always in the charge of a high official.

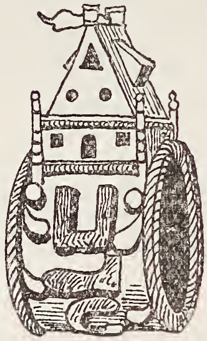
Isidorus says that at a little later date freeborn Roman men and women might wear gold rings, freed-men rings of silver, and slaves only iron rings. A decree of the senate was necessary to enable a freed-man to wear a gold ring, but slaves used to cover up their iron rings with gold foil, so as to appear freeborn. Rings of this kind are called "Samothracian."

In later Roman times the hands were frequently laden with numerous rings, a fashion revived in Europe during the middle ages. They were also often extravagant in size. Seneca says, "We adorn our fingers with rings, and a jewel is displayed on every joint." These rings were sometimes made of lapis lazuli, crystal, amber glass, and many other substances, as well as in metal.

Roman wives used to wear housekeepers' signet rings to seal up their cupboards, as well as the waxen stoppers of their wine jars. As the sanctity of the impression of the signet gradually became less marked, actual keys were made use of, and these are plentifully found in the transitional state of ring-keys, the ring part lying flat on the finger. Sometimes such rings have a signet upon them as well.

Ancient Jewish ceremonial, betrothal, and wedding rings are very large, and it is said that they had to represent a certain value.

FIG. 10.



JEWISH WEDDING RING.

Roman wedding rings were usually of iron, to symbolise the lasting nature of the union or the engagement. Marriage conditions or settlements were written down, and sealed with the *annulus signatorius*, a survival of which, though now obsolete in most cases, still remains in the form of a small wafer or place for the seal. (L.S.) A piece of loadstone, indicating the attractive power of love, was a highly-esteemed stone for an engagement ring.

Gimmal and Posy rings are both probably forms of engagement rings. The Gimmal, or double ring, fits together so as to appear as one; several of them end in two hands, which fit into each other. They are plentiful from the 14th to the 16th century, in France, Italy, and England. The "posy" or "poesie" rings have verses, names, or mottoes engraved inside them—sometimes the gimmal rings have this also, as in the case of the engagement ring made for Mr. Fitzherbert and the Prince Regent, shown at the Guelph Exhibition. This ring was in two pieces, fitting accurately together if given the proper twist, and on one piece was the Prince's name, and on the other the lady's.

In Jones' "Finger-ring Lore" will be found a long list of posies from the insides of rings. These are now and then witty, but as a rule are very commonplace—*e.g.*

"Let us Love
Like Turtledove,"

or

"God saw thee
Most fit for me,"

or

"If thee doesn't work
Thee shasn't eat."

The French posies are, as a rule, prettier—

"Mieux mourir que change ma foi,"

or rebuses like "L. A. C. D." (Elle à cédé !).

So-called regard rings, which are similar lover's gifts, are rings set with stones, the initials of which make words—*e.g.*

R uby
E merald
G arnet
A methyst
R uby
D iamond.

They are said to be a French idea, which is likely enough. A favourite sentiment is

L apis lazuli
O pal
V erd antique
E merald
M alachite
E merald.

Rings of this kind, also often enshrine names, as

B eryl
E merald
R uby
T urquoise
I acynth
E merald.

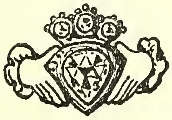
Betrothal rings were sometimes broken in two, and each piece suspended by a chain or ribbon round the neck of its particular owner. In the "Exeter Garland," this fashion is immortalised:—

"A ring of pure gold from her finger she took,
And just in the middle the same she broke;
Quoth she, 'As a token of love you this take,
And this, as a pledge, I will keep for your sake.'"

Wedding rings used to be blessed and put on the missal book at English marriages, with money. In the ancient ritual of marriage in England the wedding ring was placed on the thumb of the bride's left hand by the bridegroom with the words, "In the name of the Father;" then taken off and put on the first finger with the words, "and of the Son;" then taken off and put on the second finger with the words, "and of the Holy Ghost;" and then taken off and put on the third finger with the word, "Amen." On the third finger it remains up to the present. The breaking of a wedding ring on the finger of a wife is a prognostication of widowhood.

But sometimes it seem that English ladies wore their wedding rings permanently on their thumb. Rings are shown in pictures tied on to the wrist as a bracelet, and also, when on the finger, they were now and then guarded by a ribbon brought round and fastened on the wrist. It is not certain whether these were wedding rings or not. Some English wedding rings of the 16th century are charmingly designed with two hands holding a heart between them. The giving of a ring implies confidence, and with it the wife used to take the gift of the household keys. Not very long ago in England it was the fashion at weddings to give away numbers of rings to the invited guests. I believe this fashion was followed at the wedding of Queen Victoria.

Fig. 11.



English Wedding Ring.

During the Commonwealth the use of the wedding-ring was for a time given up, owing to what was considered its heathenish origin and the consequent Puritan scruples against it. A 17th century song says about this:—

> "They will not hear of wedding rings
> For to be used in their marriage,
> But say they're superstitious things,
> And do religion much disparage."

In the Isle of Man there was an old custom by virtue of which, if a man offended an unmarried woman and she obtained a judgment against him, the Deemster gave her a rope, a sword, and a ring. The lady then had the man's punishment in her own hands. She had either to hang him with the rope, cut off his head with the sword, or marry him with the ring.

The women of Prussia during the war of 1813 gave up their gold wedding rings to the war fund, and in lieu of them the Government gave them iron rings, inscribed "Ich gabe gold für Eisen." These iron rings are now very highly prized.

Pilgrims' rings show the marks of two feet, or a shell, as memorials of the pilgrimage to the Mount of Olives.

Decade, dicket, or rosary rings are marked with points for the saying of aves and paternoster; the more usual form is small spherical projections for the aves, and a cross for the paternoster. These curious rings were made from the 14th to the 16th century, both in France and England, and they occur in various materials—chiefly gold, bronze, or ivory.

The natural crystal of diamond is an octagon, two of the opposite points of which are more acute than the others. At the "girdle," these crystals can be divided without much difficulty, and the two points then left were easily polished, requiring no cutting, and during the 16th century particularly, in both France and England, they were set in rings, point uppermost, and used for writing or drawing upon glass. They also make very pretty rings especially when there are small enamel dots or lines on the setting near the stone. The Device of the Medici was an arrangement of three writing rings set with pointed diamonds.

There are several recorded writings made with these rings, the best known being perhaps the couplet written by Francis I. of France on one of the windows at Chambord:—

> "Souvent femme varie
> Mal habil qui s'y fie."

This was said to have alluded to the fickleness of the Duchesse d'Estampes, whose side, however, was taken by Francis's sister Marguerite who was present, and who capped the couplet with a "tu quoque."

Another well-known occasion on which such a writing ring was used was when Sir Walter Raleigh wrote on a window during an interview with Queen Elizabeth:—

> "Fain would I climb but that I fear to fall,"

which the Queen is said to have answered by writing, in her turn:—

> "If thy heart fail thee, do not climb at all."

Heraldic signet rings have been common ever since the 15th century, but now for a long time the habit of sealing letters with an impressed signet has fallen into abeyance. Such rings are, however, constantly made now, serving only as ornaments.

Several of the Italian Giardinetti rings are very ornamental, but they are usually uncomfortable to wear with other rings. The common design is a bunch of flowers in a basket, the flowers made in coloured stones and pearls. Small cut pieces of markasite are often found in these Giardinetti rings.

Poison rings were known in ancient Roman times. The Emperor Heliogabalus always wore one to use in emergency, but in the end he was murdered so suddenly that he had no time to get at his poison. Pliny describes how an erring custodian of the Capitol was condemned to torture and escaped it by biting his ring, the stone of which was a mere shell containing strong poison.

During the 16th and 17th centuries poison rings were not uncommon in Italy. The poison was sometimes contained in a small box under the bezel, or in points like a viper's tooth. The signet ring of Cæsar Borgia, dated 1503, is of gold, and inside is engraved the motto, "Fays ce que doys, avien que pourra," and a small sliding panel at the back is said to have contained poison.

Lately in Paris a collector bought an old ring in which was figured a lion with sharp claws of steel, which gave him an accidental scratch of which he nearly died. The claws were hollowed and communicated with a small poison receptacle.

A sardonyx ring, with a cameo portrait of Queen Elizabeth, was exhibited at the Society of Antiquaries in March, 1858, by the Rev. Lord John Thynne. This ring is that which was said to have been given by Queen Elizabeth to the Earl of Essex with the understanding that if ever he sent it back to her with a request, the request should be granted. Essex was presently condemned to death, and endeavoured to send this ring to the Queen with a request for forgiveness. The ring, unluckily, fell into the hands of the Countess of Nottingham, who was an enemy of the Earl's, and she annexed it herself, and it never reached the Queen. Some time afterwards, when Lady Nottingham was dying, she sent for the Queen and told her the story, on hearing which Elizabeth is said to have slapped her face, and told her that "God might forgive, but she would not."

There are other owners of "Essex" rings who dispute the authenticity of this particular ring in favour of their own.

Memorial rings are often made with pieces of hair ornamentally arranged in the shape of urns, initials, or as braided plaits with gold-wire initials upon them. They are also sometimes in the interesting form of portraits, the most numerous examples showing the likeness of any one person being those made in memory of Charles I., some of which are good pieces of work. Portrait rings are also often found containing small cameos, or intaglios. Several memorial rings of Lord Nelson show initials and coronets on a groundwork of black enamel.

In Beste's "Nowadays at Home" is told a story of the Duke of Wellington meeting Miss Dawson Damer at dinner, and noticing a ring of peculiar pattern that she was wearing. The Duke recognised the ring as being a duplicate of one King George IV. had shown him. Both of these rings had a secret spring, and this being pressed a panel opened, and within was a miniature portrait; the King's had a portrait of Mrs. Fitzherbert in it, and Mrs. Fitzherbert's had a portrait of the King in it. The Duke showed Miss Damer how to touch the spring, and inside was the King's portrait. The ring had been bequeathed to her by Mrs. Fitzherbert. The Duke then told her that the King had given him, the Duke, the fellow ring shortly before his death, and made him promise to put it on his breast when in his coffin. This request the Duke fulfilled, and so the King still wears the portrait of his wife.

Different materials used for setting in rings have had all sorts of virtues and powers attributed to them, among the most universal are, perhaps—

Emerald.—For ensuring purity of thought.
Sapphire.—Cooling; used for priests' rings, to show their coolness for worldly pleasures.
Carbuncle.—For preserving health and repressing luxury.
Turquoise.—Indicates the presence of poison or illness by changing colour.
Gold.—Cures St. Anthony's fire.
Jet.—Drives away serpents.

A silver piece collected from the communion offertory, and made into a ring, was supposed to be good for fits. Silver rings with magical inscriptions upon them were considered good for the cramp.

The proper stones for rings to be worn on certain days of the week, are as follows:—

Sunday.—*Gold* or *yellow topaz.*
Monday.—*Pearls* or *white topaz.*
Tuesday.—*Ruby* or *garnet.*
Wednesday.—*Sapphire* or *turquoise.*
Thursday.—*Amethyst.*
Friday.—*Emerald.*
Saturday.—*Diamond.*

For the months also, certain stones have long enjoyed special fitness, *e.g.* :—

January ..	Garnet,	signifying	Constancy.
February ..	Amethyst	,,	Sincerity.
March	Bloodstone	,,	Courage.
April	Diamond	,,	Innocence.
May	Emerald	,,	Success in love.
June	Agate	,,	Health.
July	Carnelian	,,	Content.

August	Sardonyx	signifying	Conjugal felicity.
September..	Chrysolite	,,	Sanity of mind.
October	Opal		Hope.
November ..	Topaz		Fidelity.
December ..	Turquoise		Truth.

Slides shown in Illustration of Nose-rings, Toe-rings, &c.

1. Golden nose ring from Sind. Shaped like a hunting horn ending in a flower-shaped disc, set with rubies and turquoises.

2. Circular nose-ring of worked gold, with venepearls and an emerald. From Goojranwalla.

3. Pewter toe-ring with hollows containing small metal balls. From Central India.

4. Labret of white marble in wooden case. From Queen Charlotte's Island.

5. Large wooden labret worn by married women. From Queen Charlotte's Island.

6. Labrets of marble and white shell set with glass beads. From the Aleutian Islands.

List of Earrings Shown.

1. Head of woman of Tibet wearing large earrings with streamers of red and green.

2. Head of a Naga of Assam wearing large earrings of grass and stained goats' hair.

3. Ancient Greek earrings of gold. Two angels bearing sun discs. Fine *repoussé* work.

4. Ancient Greek earrings of gold with angels and baskets. Fine filigree and granulated work.

5. Ancient Greek cylindrical earrings of gold, ornamented with fine filigree and granulated work.

6. Ancient Greek earring of gold with pendant oenochoe and fine rosette, with small pendant jewels.

7. Etruscan earring with small enamels and a bird in skilled glass-work.

8. Ancient Roman earring of gold, with perforated disc set with a garnet, and four pendant chains with emeralds and pearls.

9. Ancient Roman earring with grape cluster of pearls set in gold wire.

10. Ancient Roman earring of gold, with a crescent-shaped yoke set with emeralds and rubies and three pendants of jacinth.

11. Byzantine crescent-shaped earring of gold, with *cloisonné* enamels, birds, and pearl drops.

12. Russo-Byzantine earring, with *cloisonné* enamels of two birds and a small tree between them.

13. Pompeian earring, with pearl pendants, called a crotalium, from the tinkling together of the pearls when moved.

14. Earring from Benares, crescent-shaped, thickly set with diamonds, rubies and emeralds.

15. Earring from Bengal, crescent-shaped, with pendant fish. Set closely with pearls and diamonds and small emerald drops.

16. Ear plug of dark red gold, from Burmah.

17. The earrings of Queen Marie Antoinette, with large oval diamond drops.

Slides Shown in Illustration of Finger-rings.

1. Papal ring; massive, and set with a green chalcedony. On the sides the Lion of St. Mark in high relief. Italian. 15th century.

2. French Episcopal ring, with uncut sapphire. 15th century.

3. The ring of Ethelwulf, King of Britain; gold, inlaid with niello. 9th century.

4. The coronation ring of William IV. A large sapphire, in which is set a cross of St. George in rubies, all enclosed within an edge of large diamonds.

5. The coronation ring of Queen Victoria; similar to the last, but smaller.

6. Roman double ring, probably engagement, with pearl in the centre, and a garnet set in the bezel of each. 1st century.

7. English betrothal gimmal ring of gold; two clasped hands. 17th century.

8. English posy ring of gold. Inside are engraved the words, "Time lesseneth not my love." 17th century.

9. English marriage ring of gold. Two enamelled hands bearing a heart-shaped rose-cut diamond, surmounted by a coronet. Dated 1706.

10. Jewish marriage ring with representation of a temple. An Hebrew inscription is enamelled outside. 16th century.

11. Ancient Egyptian ring of gold wire with engraved scarabeus of glazed steatite. Talismanic.

12. Ancient Egyptian ring of gold with a carnelian figure of a cat engraved on the base with a "crux ansata." Worn by ladies. Talismanic.

13. Ancient Egyptian porcelain ring made in the shape of an eye, called an Ouza. Talismanic.

14. Decade, or rosary, ring of silver. English. 15th century.

15. Roman curled ring of gold ending with figures of Iris. 1st century.

16. English memorial ring with miniature portrait of Charles I. 17th century.

17. English pointed diamond writing ring. Gold, with black enamel. 16th century.

18. Italian Giardinetti ring of gold, the basket set with a diamond, and the flowers in it of rubies, sapphires, emeralds, turquoises, and small diamonds. 16th century.

19. Italian ring, probably made by Benvenuto Cellini. A large square diamond, set in a golden edge, beautifully worked and picked out black, white, red, and blue enamels. 16th century.

20. Italian ring, with enamel mask in domino. Gold, with two diamonds. 16th century.

21. Italian 16th century ring, with an eye painted in miniature.

22. Roman fancy ring of quintuple form, set with two sapphires and three garnets. 2nd century.

23. Roman housewife's bronze key-ring. Found at Verulam, in Hertfordshire.

24. Italian ring of gold, the bezel hinged, and forming a receptacle for poison. 16th century.

25. Whistle ring of gold. A hollow tube ending in a bead. On blowing through a notch in the back of the hoop a whistle is heard. English. 17th century.

26. Large gold ring from Burmah, set with nine fine rubies. Modern.

27. Oriental bow ring of jade, set with designs in gold and rubies. These rings are also used as levers for the pulling taut of the bowstring round the necks of condemned persons.

Miscellaneous.

NEW GENERATING PLANT AT NIAGARA.

In 1899 the work of enlarging the electrical power station at Niagara Falls was started, the original 50,000 horse-power having practically been taken up. During the construction of the new station that limit has actually been reached. The extension is nearly completed, and within a month or two the first generator will be at work. Generally speaking, the new house is a duplicate of that originally constructed, but it differs from this in some of its technical details. It is placed on the opposite side of the intake canal and nearer to the river, and has its turbines at the bottom of its own separate wheel pit. The discharge water is led out from this pit by a branch tunnel for about 600 ft., where it joins the main tunnel, which, it may be remembered, is of a size sufficiently large to accommodate the waste water from turbines of a total of 100,000 horse-power. The new turbines are somewhat different to those in the first house, as they are of the internal discharge type, and have the discharge water carried off through draught tubes, which add about 10 per cent. to the effective head. This increase has permitted 11 units of 5,000 horse-power instead of 10 such units to be put in a building equal in size to the first. The turbines, so we understand, were designed by Escher, Wyss and Co., of Zurich, and were built by the I. P. Morris Company, of Philadelphia. The governors, which are oil-pump worked, are designed to give a maximum variation of speed of 5 per cent. with 100 per cent. variation of load. With fractional changes in load the governing is said to be about the same as that experienced with a well designed steam engine. The electrical equipment has all been supplied by the General Electric Company of America. There are three generators, each of 5,000 horse-power (3,750 kilowatts) wound for 2,300 volts, two-phase, 25 cycles at 250 revolutions per minute. The original type was retained in the second installation because it was considered that any advantages which might accrue from winding the new machines for a higher voltage would be more than counterbalanced by the lack of interchangeability. In the new machines, however, the generator regulation has been reduced from 30 to 10 per cent. The entire plant will be worked from one switchboard, and the feeders will be provided with automatic oil circuit-breakers—these and other improvements having become possible in consequence of the advance in electrical science during the last five or six years, or found to be desirable by experience.

Six of the new generators will be of the external field type with nickel steel revolving magnet ring. These new machines are without the iron bridges over their tops, such as the older machines possessed. The reason for this is that the collector rings are placed below instead of above the machines. The armature winding is a two-circuit series closed winding, and consists of one-turn coils placed in open slots, with two coils to a slot. The coils are made up of stranded cable pressed to shape on formers. The system of ventilation employed is quite different to that used in the original machines. There is a baffle plate fixed between the bottom of the armature winding and the bottom of the revolving field. This compels all the air, which is set in motion by centrifugal force, to enter the machine at the bottom inside of the armature shell. From there the air passes outward through the air ducts in the armature core, cooling the iron and the winding in its passage. It then continues outward radially between the layers of the field winding into an annular space at the back of the field coils, and thence outward through holes in the magnet ring, which holes are bored in line with the pole piece bolts. The action is said to be that of a centrifugal blower caused by the rotation of the field poles and ring. Some of the air also passes outward at the top of the ring through holes provided for the purpose. This method of ventilation gives, so we understand, excellent results, and the air blast obtained is tremendous. From tests which have been made, it is believed that these machines will run from ten to fifteen degrees cooler than the original alternators.

The other five machines in the new house are of the internal revolving field type, this design being adopted on account of lower cost of building, simplicity of handling, and accessibility of parts. They are, however, wound for a two-phase current with 25 cycles and 2,300 volts at 250 revolutions per minute. The introduction of these two new types of alternator—for the first we have described, though similar in design, is different in character to the original machines—puts three different types in the two houses, but no trouble is anticipated in running all of them in parallel. From actual test, so we gather, the full load efficiency of one of the external field generators has come out as high as 98·15 per cent.

All the switches in the new power-house are of the General Electric electrically-operated oil break type. The cables employed in the building are heavily insulated with rubber, covered with a fire-proof braid and supported on brackets with porcelain clamp insulators. The main switchboard consists of a gallery in the centre of the building, having mounted on it 36 separate controlling panels—11 generator, 22 feed, 2 inter-connecting, and 1 exciter panel. It is intended to work the 21 generators normally in four independent groups, though all may be put in parallel together if it is so desired—that is to say, the connections have all been designed with this object in view.

Meanwhile, anticipating still further calls for power, the Niagara Falls Power Company has, through its allied company, the Canadian Niagara Power Company, started work on its new power-house on the Canadian side of the Falls, though it is not expected that this station will be at work for over a year yet. The alternators have been designed to work in parallel with those on the American side of the Falls; but they will be different in that the unit is to be of 10,000 horse-power capacity, and they will generate at 12,000 volts three-phase. The 25-cycle will be adhered to, and likewise the speed—250 revolutions per minute. For long transmission step-up transformers will be used to raise the voltage to 22,000, 40,000, or 60,000 volts. The current will be sent to Toronto and other cities in the vicinity, and will also be used by works near the Falls. Arrangements have also been made by which current can pass to the American Power System.—The *Engineer*.

PYRMONT BRIDGE, SYDNEY.[*]

What London Bridge, with its many historic associations, is to London, Pyrmont Bridge is to the capital of New South Wales, each uniting a couple of densely-populated shores, separated by a wide expanse of water; the River Thames in the one instance, and by a broad arm of Sydney Harbour in the other. Previous to 1857 communication between the two Sydney shores was conducted by means of ferry and row boats, but in that year a wooden bridge, constructed by private enterprise, at a cost of £75,000, was opened, a toll being levied on each passenger, vehicle, or animal crossing. There was a swing span in the centre, to enable masted vessels to pass through, the lowness of the bridge proving a barrier to the passage otherwise of even small steamers, the result being that the stream of bridge traffic was continually being interrupted to allow the swing span, worked by mechanical power, being used. In 1884, the bridge was purchased for the sum of £40,000 by the State Government, and the tolls abolished. This was followed by such a rapid expansion of passenger and vehicular traffic that a new bridge became indispensable, and, after various preliminaries, competitive designs were invited from various parts of the world, that obtainining the first premium being estimated to involve a cost of £295,700. Ultimately it was arranged that the new bridge should be constructed from the designs prepared by Mr. Percy Allan, M.Inst.C.E., one of the engineers in the State Department of Public Works, and an Australian by birth, a commencement being made with the actual work in September, 1899, and the structure formally opened on June 28, 1902, by Sir Harry Rawson, the State Governor, assisted by the Hon. E. W. O'Sullivan, State Minister for Public Works. The new bridge is one of the largest and most substantial yet constructed in the Commonwealth, and the experience gained during the progress of the work will naturally be utilised in connection with the proposed construction of the immense bridge across Sydney Harbour. The total length of the Pyrmont Bridge and its approaches is 1,758 feet, the bridging occupying 1,200 feet, of which 223 feet represents the length of the swing span. The area of the latter, 12,000 superficial feet, compares favourably with the 10,600 feet of the Newcastle-on-Tyne bridge swing, the 9,400 feet of the swing bridge in connection with the Manchester Ship Canal, and the 8,700 feet of the bridge swing at Hawarden. There may be larger bridge swings in the United States, but none constructed in a manner more up to date than that at Pyrmont. The heaviest work was in connection with the sinking of the caisson forming the main support of the bridge swing. This huge chamber, having a diameter of 42 feet, was commenced on August 2, 1900, and a few weeks later was completed sufficiently to permit of its being grounded, by means of girders and wedges, in the position it was intended to permanently occupy. Then it was gradually worked down a depth of 46 feet below low water mark, at which point the cutting edge touched rock on one side. The necessary damming having been completed, the water was pumped out and excavations carried on in the "dry" until a "blow" occurred, when the work had to be continued with the surface of the rock under water. The caisson, when the work of sinking had been completed, was filled wiih a solid mass of stone and concrete, representing a dead weight of over 6,800 tons. Electricity supplies the motive power for working the bridge swing; its slewing, the lifting of the ends, the operating of the gates closing the traffic, and the lighting of the roadway being controlled by a man stationed in a conning tower on the centre of the bridge. So perfect are the arrangements that by simply pressing a button the bridge—weighing 800 tons—can be opened or closed in 44 seconds. Both the slewing and lift motors are carried on a platform inside the drum, the former working through a train of gears a vertical shaft, on the lower end of which is a cast steel rack secured to the top of a pivot pier, while the end lift is effected by means of cones on horizontal shafts, worked by a 35 horse-power motor gearing on to a longitudinal shaft running the whole length of the bridge span. The materials used in the latter were iron and stone, Australian hardwood being largely employed in the construction of the other spans, twelve in number, each having a length of 82 feet; while the roadway, which is 4 feet wider than that of the Tower Bridge, London, is asphalted. The estimated cost of the structure, which possesses a substantial, yet not ungraceful, appearance, is

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[*] Contributed by Mr. John Plummer, Sydney, Australia.

£112,000, against £295,700, the estimated cost of the design obtaining the first premium in the competition open to the world, although the necessary works were on a more extended scale.

THE PRODUCTION OF PINE NEEDLE OIL IN GERMANY.

The Thuringian Mountains of Southern Germany are the home of the makers of pine needle oil extract, and similar products which are used the world over for rheumatic and kindred complaints. For the manufacture of these articles on a small scale, an ordinary pharmaceutical distillery apparatus can be used; but for a large industry, specially designed apparatus must be employed, and a firm at Jena make these up to a capacity of about 2,725 quarts of pine needles. The needles and very young shoots of the various kinds of pine trees, more particularly those of the *Pinus pumilio*, are used for the manufacture of these products. They are collected in the latter part of May or the beginning of June, and are cut up into small pieces and placed in the cylinder of the distillation apparatus. Steam enters the base of the cylinder, and is conducted underneath the bottom, which is usually made of zinc, and is perforated, the central part rising in the shape of a cone or funnel. Through the perforations the steam finds it way to the needles heaped up in the cylinder, and the volatile oils contained there are freed, and make their exit, together with the steam by means of a pipe which connects with the cooling cylinder. Cold water runs continually from the top into this cylinder, playing around the so-called "serpent pipe," and cooling its contents, and then finding an exit at the bottom. Thus, the contents of the serpent pipe become condensed, and the liquid runs into a bottle at the base of the cooling cylinder, where the oil is found swimming on the surface. The oil must from time to time be skimmed off, while the water runs out at another pipe. As this water is not entirely free from the oils, it is generally subjected to a rectifying process, in order to save the oil, which would otherwise be wasted, or the separation can be effected by the application of salts. In preparing the pine needle extract for medicating baths, when the steam has extracted the oils from the mass in the distilling cylinder, the condensed water (containing resinous, albuminous, and laminated substances) drops through certain perforations, and collects in a space below; thence it is drawn off by means of a tap, and taken by a pipe to a vacuum apparatus. The boiler is half filled with the condensed water, which by means of steam entering through a pipe, and passing underneath the boiler, is heated and caused to evaporate. The process is greatly aided by the fact that the space above it is void of air, this having been drawn out by means of a pump. The evaporating process is continued until the contents have reached the desired consistency. The extract is then drawn off, mixed with pine needle oil in order to give it the necessary perfume, and put up in jars. The mass left in the cylinder after both the above described processes are finished, is dried and put into a machine to separate and loosen the several fibres. These are then perfumed with pine needle oil, put up in assorted packages, and sent to the different markets, where they are sold for pillow and mattress stuffing. The fibre is considered very healthy, and vermin-proof.

General Notes.

Patents in Germany.—In 1900 there were 1,565 patents taken out for electrical inventions in Germany. For telegraphs and telephones the patents numbered 283; for primary batteries and accumulators, 208; thermopile, cables, and distributing system, 368; motors and distribution accessories, 199; meters, &c., 149; lighting, 250; auxiliary apparatus, 58; heating and cooking, 50.

Proposed Slav Exhibition.—A Reuter message from St. Petersburg says that an art and industrial exhibition of the Slav countries is to be held at the Imperial Taurida Palace in St. Petersburg in 1904. M. Kovalevsky, Assistant Minister of Finance, is president of the central organising committee sitting at St. Petersburg, and sub-committees are being formed in Bulgaria, Servia, and Montenegro. The exhibition will be of a strictly ethnographical nature, and the articles will be classed according to the nations which produce them. It is hoped that all nations will be represented.

Technical Education.—A return recently issued shows that the amount spent on technical education in England and Wales by local authorities during 1900-1, exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, was £1,051,422 0s. 9d. The amount raised by loan on the security of the local rate under the Technical Instructions Acts was £152,833 14s. 4d. The amount of the residue received under the local taxation (Customs and Excise) Act by councils of counties and county boroughs in England (excepting Monmouth County) for 1900-1 was £924,359 19s. 10d., of which £863,846 11s. 5d. was appropriated to educational purposes, and £60,513 8s. 5d. to relief of rates, the latter sum including £32,711 9s. 2d., devoted by the London County Council to the relief of rates. The amount of residue paid to the county and borough councils in Wales and Monmouth was £44,358 5s. 10d., the whole of which was devoted to intermediate and technical education, chiefly under the intermediate Education Act. The various councils are making grants out of rates under the Technical Instruction Acts, and the total amount expended on technical education under these Acts during the year was £44,791 4s. 9d.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1903.

The prize is offered to the student who obtains the highest awards in the following subjects :—

(*a.*) A finished drawing of imperial size from the nude living model.

(*b.*) A set of time studies, on a small scale, from the nude living model, executed in a short time, of varied shortly sustained poses (mounted on not more than two imperial size mounts).

(*c.*) A set of studies of hands and feet from the living model (mounted on not more than two imperial size mounts).

(*d.*) Drawing from the life, including memory life drawing, done at the Examination on May 9, 1903.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892, 1893, or 1896, cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Board of Education, South Kensington, in April, 1903. Each competing drawing must be marked "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Board of Education.

Proceedings of the Society.

CANTOR LECTURES.

HISTORY OF PERSONAL JEWELLERY FROM PREHISTORIC TIMES.

By Cyril Davenport, F.S.A.

Lecture III.—Delivered February 24, 1902.

Jewels, Pendants, Brooches, Summary.

The diamond alone among precious stones is composed of pure crystallised carbon, and is in all probability of direct vegetable origin. This view has been upheld by many eminent men of science, among others by Sir Isaac Newton and Sir David Brewster. The probable sequence of formation is supposed to be—forest tree, turf, lignite, coal, cannel coal, jet, black marble; then certain conditions of heat and pressure under the influences of which the crystallisation takes place. Experimentally, films of diamond have been produced by enclosing a block of pure carbon within an iron cylinder, in which it could not expand, and then sending through it a strong electric current. But as far as experimentalists in this direction have yet gone, it appears that to make a crystal of diamond of any useful size would be so costly a proceeding that it would not be worth the trouble and expense.

The natural crystalline form of a diamond is octahedral—like two pyramids joined at their bases, and halves of crystals of this form, polished and set points uppermost were largely used during the 16th century in Europe for setting in rings for the purpose of writing upon glass. Irregularly shaped stones can usually be reduced to the simple form by skilful cleavage, and all well-cut diamonds are made from stones which have so been chipped into the form of a double pyramid.

It is said that Louis de Berghem, of Bruges, found out accidentally, in the 15th century, that two diamonds rubbed against each other would in time become polished where the friction had taken place, and from this standpoint he further proceeded actually to cut diamonds with facets, by attrition against each other.

There is, however, little doubt that the superficial cutting of diamonds into facets was known in India long before the time of Berghem. In 1665, the traveller, Tavernier, found that the art of diamond-cutting was fully established there, but if the stones were naturally clear and well-shaped, they were frequently only polished on their natural surfaces, and not chipped, shaped, or facetted at all. If flawed, however, the defective part was freely removed.

The finest Indian diamonds come from Visapur or Golconda, and we also get them now from Borneo, Brazil, Sumatra, the mines of Antioquia, Columbia, Siberia, California, and the Cape.

Most of the forms of cut diamonds can easily be seen to be based upon the original double pyramidal form of the crystal; some of them in the single pyramidal form, which is really only the other cut in two. The upper and lower apices being ground down, gives the "Table" form, long highly esteemed. An imperfect crystal, with only one apex and a flat base, being ground down as to its apex, forms what was called a "lasque."

The Indian fashion of cutting an irregularly-shaped stone all over with small facets, was no doubt the original of the "Rose" cutting, which is the same thing, only more carefully measured and executed. The Rose was a favourite form in Europe during the 17th century and after, and it was very likely first used by Italian or Dutch lapidaries. The true "Dutch Rose" has 24 facets; the base of a rose is flat—it is really a half-crystal.

Towards the end of the 17th century, Vicenzio Peruzzi, of Venice, is said to have invented the "Brilliant" form of cutting. Cardinal Mazarin is also supposed to have helped to establish the new cutting by his patronage, and dissatisfaction with existing forms. From 1641 to 1653, Cardinal Mazarin interested himself much in the cutting of diamonds, thinking that more brilliancy could be procured by some other methods of facetting than those of the Table and Rose forms then in use. He eventually induced a lapidary to try a new arrangement called "Taille en seize," which is said to have been more effective than anything yet done, and twelve stones were cut in this manner for the French crown—these were called "The Twelve Mazarins."

A true Brilliant, as finally determined, should have 32 facets above, and 24 below the girdle of the stone—56 facets in all. The upper surface still retains the name of the Table, and all the other facets and parts of the stone are named. The stones are first chipped into shape, as nearly as possible, the crystal of diamond being easily flaked off in the direction of its natural faces, and then ground and polished laboriously with oil and diamond dust.

The weight of diamonds is often much diminished by cutting. The weight is calculated by "carats," a word derived from "κεράτιον" meaning the seed of a small vetch. These seeds are remarkably uniform in weight, being about $3\frac{3}{4}$ grains Troy, but, of course, now they are not actually used, as they once undoubtedly were.

In the 18th century, cut diamonds were often backed with a black varnish, made of mastic and ivory black, or sometimes with black silk. The transparent setting of stones is quite a modern innovation. It is always difficult to judge the true colour of any backed stone. Varnished diamonds used to be kept in water at night, so as to preserve the varnish.

Diamonds have not often been cut as signets, because of the extreme technical difficulty and tediousness of the operation. It is not, however, unknown. I have seen one bearing a profile portrait of Queen Victoria, and at Windsor is the yellow diamond signet of Charles II., engraved with the ostrich plumes of the Prince of Wales.

Diamonds are now and then beautifully coloured, a yellow tinge is perhaps commonest, then pink, then blue. The finest blue diamond is that known as the "Hope." It is like a fine sapphire, with brilliant prismatic play of light, and is set as a brooch, within a border of white diamonds. It is supposed, like the Koh-i-Noor, to be a fragment of a larger stone. Black diamonds are only curious, and Bort, a formless mass more or less grey or dark in colour, and of no ornamental use, is diamond in an abortive form, and is crushed into powder to polish other diamonds with. A green diamond is a great rarity; I have never seen one.

Coloured stones belong to one or other of the remaining two great classes of jewels, those having alumina as a base, or those having silica as a base. To the first group belong all the harder stones known as corundum; in this group are included rubies, sapphires, emeralds, as well as the stones described with the prefix "oriental," all of which are very hard. The colouring matter is approximately the same in stones as well as in glass enamels, and roughly, the reds are caused by oxide of iron, and greens and yellows by chromic oxide. There are many other colouring oxides, but these are the most usual, and a very small proportion of them will give a very rich colouring.

The stones with the base silica include all quartzes, beginning with rock crystal. This clear crystal when stained by the infiltration of one or other of the metallic oxides, becomes more or less intense in colour, and differently coloured stones are known by different names, amethyst, aquamarine, topaz, peridot, tourmaline (a stone assuming many colours and remarkable for its curious optical qualities), garnet, spinel, cats-eye, and numbers of others. In this class also come the numerous agates and onyx.

Opal is a vitreous stone full of small fissures, the surfaces of which are striated with microscopic lines which break up the normal white ray into its coloured parts, and thereby give the impression of colour. The opal is very soft, and soon loses its polish, and the iridescence is quite destroyed by grease. Damp will destroy the iridescence temporarily, but it can in this case be restored by warming the stone before a fire. The Fire-opal is a deep orange stone of great beauty.

Coloured stones, until the period of the Renaissance, were used in jewellery much in their natural shapes, but superficially polished. This is called "cabochon." As lapidaries became more skilful the stones were given more accurately oval forms; and about the 15th century they were first cut and facetted in Europe, as they generally are now. The manner of cutting coloured stones is much the same as would be used in the case of a diamond, and is usually a modification of the "Brilliant" form for small stones, and the "Table" for larger ones.

Vitreous enamels, which were certainly used in jewellery from the time of the ancient Etruscans, in the 6th or 7th century B.C., are glass fused upon metal. Enamel glass is coloured with metallic oxides, and is opaque or transparent. All ancient enamel work is opaque, oxide of tin being used in all cases, and a colouring oxide as well sometimes. Opaque enamel is easy to manage with a blowpipe, and melts at a low heat. Transparent enamel which was probably first used in Europe about the 15th century, is difficult to manage, and requires considerable heat.

Opaque enamel is suited to cloisonné or champlevé work, but transparent enamel shows best when the metallic ground is carefully engraved in the manner known as basse-taille—the deeper portions showing darker than the more lighhtly treated parts. I am glad to say that the use of enamels in jewellery shows distinct signs of revival, and there is no more beautiful accessory to gold and jewelled work.

Transparent enamels always do best on fine gold; on silver they are sadly apt to chip off readily, and on copper they are very likely to assume a semi-opacity, but now and then will fire well.

Pearls are formed within the shells of the pearly oyster (*Meleagrina margaritifera*), round some small nucleus. Baroque pearls are of irregular shape, but often contain finely-shaped pearls within them. Much of the value of a pearl depends upon its shape, which cannot be improved without lessening its size. A pearl is made like an onion, in successive layers, so it can be skinned, as it were, and this process is often used to get rid of bad colour. The beautiful play of iridescent light on the surface of a pearl is due to the breaking up of the rays of light impinging upon the ragged transparent edges of the fine layers. Very old pearls lose this transparency, and only look like dull lumps of chalk.

Sham pearls have been largely made, and have been, and still are, an important branch of modern industry. The best of these are made at Venice; they are small, spherical beads of glass, blown in with powder made of the crushed scales of the Blay, a small flat fish, and then filled with wax. A certain proportion of these beads are beautiful, and have very nearly the appearance of the real pearl.

The Swastika is probably an ancient symbol of the solar motion, the crampons indicating movement. In ancient mythology the sun was often represented as a wheel. The swastika is found largely distributed. It occurs in leaden and clay idols found at Troy—plentifully in Indian art as well as in Scandinavian. The triskele is found more particularly in Anglo-Saxon art. The Greeks and Romans, however, both used it. The word appears to be originally Sanskrit, "Sa" "well" and "as" to be, and is the sign of good wishes, or prosperity.

The sign is frequent on Trojan terra cotta balls and spindle wheels, both forms, Swastika and Suwastika, being represented. It sometimes occurs in conjunction with the zigzags supposed to represent lightning. It is known also as the gammadion and the fylfot. It represents eventually the highest deity.

Burnouf thinks the swastika was originally only the two sticks laid at right angles to each other before the sacrificial altars to produce the sacred fire by means of another pointed stick rotated upon them. In this way it may have become a symbol of sacred fire. It is found in early work of all kinds in nearly all the countries of Europe and in many of Asia. A row of swastikas are sculptured round the old pulpit of San Ambrogio at Milan.

It is found sculptured in the catacombs at Rome, in wall paintings at Pompeii, on Celtic urns and ornaments found in Britain, and on terra cottas and gold plates found at Mycenæ, also at Athens and Cyprus. It is also the original motive of the Greek Fret.

In the Chaldean astronomy the representation of the sun commences as a circle, soon increased by the insertion of a cross or spokes within it. The Indians also use a simple ring—which to-day remains as the caste mark of the Sauras or sun worshippers.

The triskele is probably the same sign, but with three spokes or rays instead of four. In both cases the rays are frequently found curved, in which case they are often called snake signs. The three legs used as the coat of arms of the Isle of Man, are a familiar form of the triskele. It is doubtless a sign of the Trinity, an almost universal deistic idea among the cultured races of antiquity; as well as the swastika, it plentifully occurs in the art of Northern Europe, having come up from the south.

The ring-cross is a sacred symbol of the stone and bronze ages, and came no doubt from Asia. It may, perhaps, have indicated the wheels of the sun carriage. Divinities were supposed to live in the sun, and so the sun signs in time came to mean the divinities themselves.

BROOCHES.

The articles of ornamental jewellery that we have already considered can all be worn next the skin. They probably were in fact so worn by our savage ancestors long before they found any necessity for clothing, and in a majority of cases they are still worn next the skin. Necklaces and bracelets sometimes are put on over the dress, and rings are rarely worn over gloves. With these unimportant exceptions the manner of wearing the earlier articles of decoration is practically the same as it originally was.

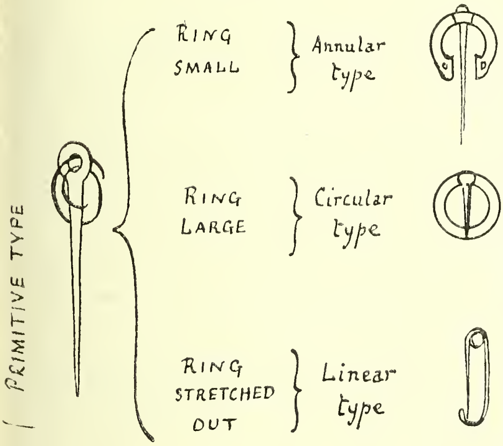
At some remote period primitive man gradually migrated northward from the tropical belt in which he probably first came into existence, and as he felt the colder temperature inconvenient, especially at night, he found it advisable to invent some sort of covering or clothing, by means of which he could obtain warmth. Some races of mankind under these circumstances probably developed hairiness—the survival of them still existing in the hairy Ainus, so well described by Mr. Landor. But no doubt the majority of man kind remained in their comparatively hairless condition until the almost universal use of clothing finally determined their position as hairless. What the first clothing was it is of course impossible now to say, but it may be conjectured to have consisted of belts of grass or leaves knotted together either by their own stalks or by accessory vegetable fibres. When men became hunters, which they did not do until they had progressed far enough to have invented offensive weapons, they no doubt soon used dried skins for clothing. A rough tanning of such skins could have been managed by rubbing them with fat. Then came the difficulty of fastening them. Some savage tribes still wear cloaks which have only a hole cut for the head to go through, and this is likely enough to be a primitive type; then also they might have been tied up with strips of sinew, but at an early stage they were pinned together with a bone or large thorn. Here is the germ of the brooch.

Numbers of such pins have been found in all places where the remains of primitive man exist, and they range from the simplest forms to quite ornamental ones. The heads of the carved specimens show a certain amount of progression, and are often decorated with engraved lines, dots, and circles. Ivory, wood, and bone are all commonly used, and in time, as metal workings became known, these carved pins are imitated in bronze or gold. From the Stone age, through the Bronze age, up to the Iron age, in which I believe we are still considered to be, pins and their derivatives, brooches and buckles, have been universally used, and it is an interesting study to endeavour to trace their utilitarian development as well as their artistic and technical beauties.

Starting with the earliest metal pins, which are of bronze, it soon appears that the head or thickened end is treated ornamentally, hammered flat, and pierced. Into the pierced hole in the top of pins are often found wire rings coiled several times, or single rings, as in plenty of specimens found in Ireland. In other cases of Roman pins found in Britain, there are chains of which a few links only are left, and in one case at least a pin the head of which was threaded with a chain of several links, was found among the *débris* of one of the Swiss lake dwellings.

I take it that these chains at one time were as long as the pin itself, and that the last ring was in all probability hooked over the point when the pin had been inserted in the garment it was intended to fasten. It is understandable that a large pin fastening rough garments of skins together firmly must have a considerable proportion of its point exposed, and this point must have often annoyed its owner by catching in other things than those it was intended for, as well as scratching his own fingers, and generally making itself felt in an unsatisfactory way. It is, therefore, likely that a covering for the sharp point was advisable for many reasons, and I think the chains, remains of which are constantly found, mark the commencement of a series of contrivances for protecting the point itself from injury as well as for preventing extraneous injury.

Fig. 12.

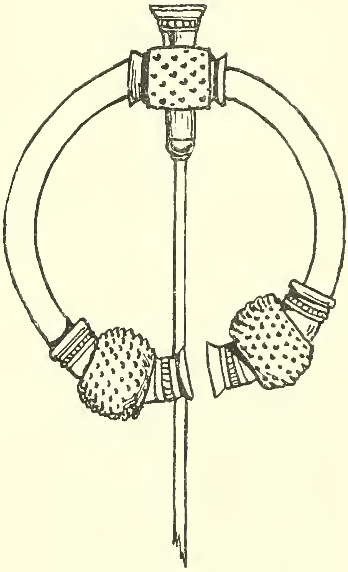


In all the subsequent developments of the chain-pin, the chain is the part which undergoes change. It solidifies, thickens and becomes ornamental as well as useful, but it appears to develop particularly in three lines, varying in the proportion of the length of the pin to the arc, as well as in the general shape of the arc or its equivalent. Etymology here gives a little helping word to the pin of bone on its way upwards to the beautiful brooch—περόνη means at first a "small bone," then it means a "pin," then it means a "brooch." The Greeks also fully saw the double-constructive anatomy of a brooch, and gave a separate name to the arc, "κλεις." The French word "Broche" means at first a spit, then a brooch. The pin of a brooch goes twice through the material it fastens; the Greeks realised this, and called a brooch "δίβολος," in distinction to the pin of a buckle which, as we shall see, only pierces the material once.

My diagram (Fig. 12) will show clearly the three lines upon which the early pin develops, and in my slides I shall show you some of the most celebrated instances of the three kinds which are as yet known. Among examples of the two first divisions, the Annular and the Circular types, occur several instances of celebrated brooches, known by their own names, but among the fibulæ of the third division, the Linear, I know of no brooch of importance enough to be separately named.

The finest examples of the *Annular* type of brooch are to be found among the Celtic brooches found in Scotland or in Ireland. Several of these have exquisite gold tracery upon them, designed in the well-known interlaced manner characteristic of early Celtic art, the scrolls frequently ending in conventional animals' heads. Jewels of little value, cut *en cabochon*, and pieces of coloured glass, amber bosses, and now and then fine pieces of vitreous enamel work, occur in the rings of these brooches. The ring part is always very much less in diameter than the length of the pin, and some of the rings are entire, others, as is more common, are pen-annular. In this last case, the pin is run through the material

Fig. 13.



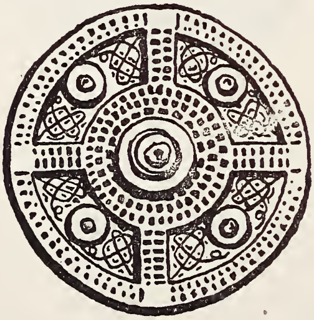
Anglo-Saxon Brooch—Pen-annular Type.

up to the head, then the movable ring is tucked under it, above the material, and given a half-turn, which fixes the whole thing very firmly. The ornamental ends of several of the pen-annular brooches are copied from natural objects, as may be seen in the "Arbutus" brooch, having at the ends a conventional arbutus berry. In the more decorative cases, the ends of the ring are flattened out into irregular plaques, and on them the fine jeweller's work and inlay work is done. The most celebrated instances of this are to be found on the Hunterston, Tara, or Ardagh brooches, but there are several others of less celebrity with workmanship of nearly as fine a character.

The pen-annular brooches are not, however, peculiar to Celtic people, as they are really widely distributed, representing as they doubtless do, a very early type. At the present time, they are in great actual use in Algeria, and other parts of Northern Africa, the main difference between these and the Celtic brooches being that, in the case of the African specimens, the decoration is usually carried out as an ornamental extension of the head of the pin itself rather than in the ring. The principle of attachment remains the same.

The second division into which the decorative arc of the brooch falls, is the *circular*. In this case, the diameter of the ring equals the length of the pin. In the first forms of this kind, the rings remain open, but in later forms it solidifies, and is filled up, becoming the prototype of the most numerous class of ornamental brooches. Round, oval, or rectangular brooches belong to this class, and the ornamentation upon them is infinite in character from the almost plain disc to the most elaborate of the beautiful Anglo-Saxon pearled and enamelled brooches. All single stone brooches, like the Koh-i-Noor or the Hope Blue Diamond, belong to this class. Among the more celebrated brooches in this division, may be cited the Hamilton Brooch, the Lorn, Lochbuy, and Glenlyon brooches.

Fig. 14.



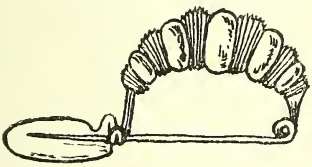
Anglo-Saxon Brooch – Circular Type.

Fine specimens of the open-ring brooches are found of early Lombardic, Scandinavian, and 14th century English work. These have frequently curiously-modelled figures of birds and animals in the round upon them, and the English examples are often set with fine jewels. From the open-ring brooch, good instances of which are not uncommonly found among the Roman remains in Britain, buckles derive directly. The radical difference between a brooch and a buckle is that the pin of the latter only pierces the material it is used to fasten together once, whereas the pin of the brooch pierces it twice. In the case of the buckle, the place of the second piercing may be said to be taken by the fastening of the head of the ring to a strap or the edge of the material. This head is often enlarged into what is called a buckle-plate, which is often beautifully ornamented, especially by early Merovingian and Anglo-Saxon jewellers. Made of bronze or gold, or bronze overlaid with gold, these buckle-plates are often covered with small *cloisons*, into which are set little pieces of flat garnet and a blue or green composition. They are also sometimes, in Anglo-Saxon specimens, adorned with small figures of fish, birds, or animals, treated in a like manner to Lombardic work. The buckle with a bar across it is an afterthought; it first shows on the Glenlyon brooch, but its usefulness soon became apparent, and it is a good example of the curious way in which a certain form may usefully develop from another, and then improve itself on entirely new lines. The existence of buckles, with several pins, is another instance of special development, as also is the new invention of widening the point of the pin itself into a rounded eye, fitted with a padlock. In this case, of course, the holes in the tongue are made very large, the pin having of itself no piercing power whatever.

The third division into which I have divided my brooches, may be called the *linear*, as it gets rid of the ring form, and substitutes a straight line, of metal, or what represents it, for chain or circle. These brooches are more properly known as fibulæ, the straightened out ring is now the same length as the pin, but it is more or less arched, the head of it forming a hinge or spiral, the point turning into a small saucer-like trench into which the point of the pin fits.

The modern safety-pin is quite the same in all essential points as one which was found by Dr. Henry Schliemann at Mycenæ, and the same form, with the arch more or less specialised in design, has been very largely used North and South, East and West. The Greeks made the arch short, and enlarged and ornamented the nose or hollow for the pin to rest in; the Romans made the arch big, and set it with beads of amber and bronze, and fretted it out in innumerable ways, curves, spirals, and all sorts of twists and turns which the fancy of the artist could devise. The Roman fibulæ are more usually made of bronze or silver, but the Greek are largely of gold, and of exquisite workmanship.

Fig. 15.



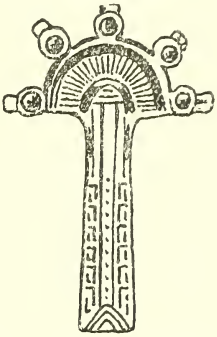
Roman Fibula.

Some of the German fibulæ are curiously arranged so as to fasten with the arch downwards, and to this arch are fastened fringes and pendents of metal discs and chains. This might be a very useful and decorative kind of brooch in competent hands. I have seen several instances of modern safety-pins the arch of which is jewelled, but I have never seen one treated in a modern way on the Hallstadt model.

The Romans early enough made their fibulæ of one piece of wire, bent round at the head into a double or triple coil, so as to form a spring. In doing this, they quickly found it was easier to make the small turn on some kind of core, and probably they used a small stick for the purpose; and one day the stick—or perhaps a short piece of metal—stuck in the coil, and the artist saw that it was a decorative feature, and numbers of Roman brooches have this kind of cross-bar at the top. It is, however, often explained as representing the cross, or Tau; indeed, these fibulæ are known as Tau brooches. I think it more likely that the constructive explanation is the safer, as I believe that many of these brooches were made long before the Christian era.

However this may be, the Roman Tau brooches gave rise to a very decorative form of fibulæ. These are the very elaborately-wrought brooches of Scandinavia, which have a large rectangular or semi-circular top. This top is clearly an enlarged form of the cross-bar, but it is so distant from it and so highly ornamented that the connection between the two is not evident at first sight. There are also numbers of beautiful Anglo-Saxon brooches designed on similar lines, but more delicately worked with much more reserve in the lines as well as in the workmanship. The long Scandinavian brooches are usually made of metal alone, where the Anglo-Saxon are largely ornamented with inlays of garnet, and silver lines with niello patterns upon them. In both cases the body of the brooch is long in proportion to the diameter of the rectangular or semi-spherical head, and is equally ornamented.

Fig. 16.



Anglo-Saxon Brooch—Linear Type.

In early Roman brooches where the turn-over at the head has required some little arrangement so as to bring over the "arc" part in a different direction, the pattern made by the wire curves is peculiar. When this fibula reached the northern part of Europe in Scandinavia, the artists there filled in, or covered up, the upper wire with a solid plate, and turned it into what is known as the "Boar's head" brooch, but curiously enough the pattern of the original turn of the Roman wire fibula shows in many cases outlined on the top of the Boar's head. These large decadent brooches are the ultimate northern outcome of the safety-pin, as they are so heavy and cumbersome that they would pull any ordinary material to pieces. Being the ultimate outcome, they have not developed further at all. In the same way the Celtic annular brooches in their turn are the ultimate Western development of a ring fastened at the head of a pin. Both these forms then have, for the present, ceased to develop, but the circular brooch and its endless variations is still alive, and yields a rich field for designer and workmen, advantage of which is, I fear, hardly taken to its full extent, although there are signs that a new feeling is growing up with regard to brooch designs. It will, unfortunately, be a long time, I fear, before the taste for small brooch models of favourite toys quite goes out from among us.

PENDANTS.

Pendants as a rule belong to necklaces, but they are so various, and designed in ways which are so peculiar to themselves, particularly in the 16th, 17th, and 18th centuries, that I feel they have some claim to be considered as a class by themselves.

The small pendants which occur numerously in ancient Egyptian, Greek, Etruscan, Phœnician, and Rhodian necklaces, although taken separately, may be considered as true pendants, nevertheless they are sometimes so repeated and strung together, that they become actually integral parts of the necklace itself, and are so considered in their proper place. On the other hand, the pendants now under consideration are made either to be suspended on any chain which may be worn at the moment, or else have a small and unimportant chain of their own—used only for the purpose of suspension. One easy distinction is possibly the surest test of this difference, it is that of size. If, for instance, any pendant exceeds any other pendant on its own chain by a couple of inches or so, I think it is worthy to be considered as a separate jewel.

On necklaces of ancient Egypt appear pendants, among the most curious of which are three large golden flies, on a cleverly-made chain (probably 1800 B.C.), according to Emil Fontenay. The Phœnicians worked pendants charmingly, with delicate granulations. Their jewellery is, as a rule, remarkable for its quality of thinness, and similar granulations show in several of the beautiful Greek and Etruscan pendants, many of which exemplify the art of their time at its best. In some of the Etruscan necklaces are found bullæ, the original form of which is circular and double —two faces soldered together at their edges— but this form soon became modified. The original bulla was really only a form of amulet, as foreign substances were enclosed between its two faces. Rats ears and livers were prophylactics against the evil eye. A dried bat's head induced sleep; other odds and ends cured toothache. Serpent's eggs were likely to cause the success of their wearer in law suits. Sometimes they enclosed conjurations against demons and evil influences engraved upon small plates of metal, silver, or gold. The wearing of amulets no doubt originated in the East, and they were not only worn in bullæ, but attached to bracelets, earrings, set in rings, hairpins, and even in belts, or sewn into the garments.

Agates preserved the wearer against bites of insects, and had the power of turning away or dispersing thunder storms, but for this purpose they had to be tied in with lion's hair. The diamond cured melancholy, and quieted trouble or sorrow. Amethyst was a preventive against intoxication, and if the names of the sun and moon were engraved on stones they prevented poison from acting, and frightened away hail and locusts.

Besides the magical contents of the bullæ these sometimes were engraved with powerful signs, as the swastika, already mentioned. The belief in these signs and mysteries dates from very remote times, and is not even now quite extinct. The belief in the efficacy of small pointed pieces of coral or other material against the power of the evil eye is still very strong in Italy, and there are other smaller superstitions without number among uneducated people. The belief of the luck in a horse-shoe is still strong, even in our England.

Among the Romans of about the 1st century, the Augustan age, no doubt cameos were largely used as pendants; coins also, richly set, were also used. Charlemagne, in the 8th century, wore a splendid reliquary as his necklace, which was sent to him by Haroun-al-Raschid. This was buried with him, and was found on his neck when the body was exhumed in 1169. In 1804 this reliquary was given to the Emperor Napoleon I. by the clergy of Aix-la-Chapelle, and latterly it belonged to Napoleon III. Under a pale blue sapphire are set a piece of the true cross and a thorn from the crown of thorns. The sapphire is magnificently set in gold and gems.

Up to the end of the 15th century, the majority of pendants were indeed amulets, more or less ornamentally treated, but after that time this character gradually died out, and the decorative value of the pendant alone became the object of consideration. From contemporary portraits some idea can be formed of the almost universal use by great people of pendants of great beauty—crosses, edallions, or only ornaments, but enough the actual objects of this time exist, enable us to realise what charming and aborate works of art many of these pendants ere. Vitreous enamels usually play a large art in their ornamentation, and there is a rofusion of jewels, and much fine, good work, ast, hammered, moulded, and chased in all inds of ways, and usually a free use of pendant pearls. Where round shapes were used n oval form now is generally substituted, but he more ornate pendants are irregular in form. ameos are often used, sometimes antique, ometimes Renaissance, set in very beautiful nounts of gold, jewels, and enamels in rich uxtaposition. Benvenuto Cellini is credited vith having designed some of these settings—wo attributed to him are now at Paris, one of n architectural design.

Some of the prettiest of the Italian 16th century pendants represent little ships, a design carried out frequently by jewellers of other nations, but never so charmingly as those of Italy.

During the 16th century in France, there were several excellent designers for pendants, and jewellery in general, but as far as is known their designs were not carried out at the time—if ever. The best of these designers were Jean Collaert, Androuet du Cerceau, Jean Vovert, Woeriot, Theodore de Bry, and Stephanus. The designs are largely allegorical, scenes from Biblical history, or love scenes, all enclosed in most elaborate and rich framework. Enamels were evidently intended to be largely used.

The use of ornamental monograms in jewellery began during the 14th century.

A charming pendant of Queen Elizabeth in enamelled gold is in the British Museum, and shows that the English jewellers, although their output was small, were not behind their Continental rivals in technical excellence and power of design.

Diamonds used in jewellery before the beginning of the 17th century (1600) are always cut, either as "Tables" or "Roses," the "Brilliant" not being then invented, and all coloured stones were cut in the rounded form known as "Cabochon."

The Germans took example by the French enamellers in the matter of pendants, and during the 16th century made numbers of such jewels, in the centre of which are usually little figures. These are all very decorative and wonderfully elaborate, but they are very commonly overburdened with detail. Some of the simpler ones, on the other hand, are almost cumbrous in design, although richly jewelled and admirably worked from the jeweller's, enameller's, and lapidary's point of view. The Italian works of this kind and period are the best in every way. The decadence of which these over-elaborated works are a sign, eventually culminated in forming a school of its own, which, in its way, is interesting and not altogether without beauty, it is called Rococo, and the chief essential is the presence of both enamelled work and jewels together.

The Museum at Dresden is rich in specimens of the German work of this kind, and by the munificent bequest of the late Ferdinand Rothschild, the British Museum is now possessed of several specimens of the first importance.

A French jeweller, named Daniel Mignot, during the beginning of the 17th century, is supposed to have first set rows of jewels close together in consecutive order. This notion was, of course, very suitable for working the monograms then so prevalent, and it has been more or less used ever since.

From the 16th century pearls were much in fashion, and pendants commonly have single pearls or groups of pearls dependent from them.

Towards the end of the 17th century pendants are found made of gold only, but exquisitely pierced, chased, and engraved, and some specimens of Portuguese work are remarkable for delicacy of execution, these are sometimes set with very small diamonds.

The well-known Norman crosses of metal work, some of which is excellent, have the settings of the crystals abnormally exaggerated in size.

Sprays of leaves and flowers, and knots of ribbon, during the 17th century, are made in metal, and thickly set with crystals—paste or real jewels—particularly by Venetian, French, and Portuguese, followed at a safe distance by English workmen. The best of these are by Gilles Légare, and in the 18th century his follower, Pierre Bourdon.

The jewellers of the beginning of the 18th century did not hesitate to mix gold and silver in their jewellery. Gold was commonly used for the settings of coloured stones, and silver for diamonds.

During the Empire classical taste prevailed, the pendants are beautifully worked; various designs of vases and flowers, enamelled and jewelled, souvenirs of the ancient Bulla. Cameos once again were the fashion, and diamonds and pearls reappeared after their eclipse during the revolutionary period.

Lockets, so favourite in England during the latter half of the 19th century, and not unknown before that time, are pendants, but like the Bullæ, they are usually valued for their contents, hair or portrait. Renaissance designs are most suitable for enamels. A few beautiful designs were made by Froment Meurice, but the locket part is usually quite insignificant, the setting being the part which is fully ornamental.

TOOLS.—SUMMARY.

A very interesting point about ancient jewellery lies in the consideration of the manner of its working and of the tools with which it was probably wrought. As a general distinction between the larger methods followed by ancient as compared with modern jewellers, it may be said that the former worked more by himself. His work was rarely parcelled out or sub-divided, but was followed out from design to finish by one man. He liked *tours-de-force*, such as a chain of rings made by the hammer out of a single bar, and many instances of the successful working out of such puzzles are known. The use of the hammer, anvil and file is very ancient, and although no doubt annealing by heat must have been known to early workers in hammer work, the very interesting and valuable discovery of soldering, which very likely was accidentally discovered in following out the annealing process, was not hit upon until a comparatively late period.

In old work is found simplicity of means with variety of results, and there probably was a small *clientèle*; in new work is found complication of means with uniformity of results and a large *clientèle*.

Until the middle of the 14th century religious feeling in jewellery largely preponderates, reliquaries of all kinds in rings and pendants. In the 15th century, gold and silver variously wrought had chief vogue, buckles and all kinds of ornaments for dress. In the 16th and 17th centuries flourished the beautiful arts of chasing, enamelling, and inlays of various sorts, weight being not so highly considered as just before, but workmanship having a higher appreciation.

The management of small and delicately-designed ornaments now required much soldering and alloys for colouring gold, and the official standards of the precious metals were lowered. Then began a curious struggle b tween the goldsmiths and the Mints, o wanting a low standard and the other a hi one. One result of these disputes was to low the standard for coinage to such a point th it would not pay to melt it up and use it f jewellery. At the present time, for instanc you can purchase for about 1s. 8d. as mu silver as is in a half-crown, so that obvious it would not pay to melt up the coin.

Towards the end of the 16th century, massi plate came again into favour, and silver w largely made use of for ornamental purposes Claude Ballin even used it for covering table And from this time onwards, small jeweller became the vogue—so small, that it frequentl is not even Hall-marked, and this, of cours tends largely to tempt jewellers to use metal a very low standard.

In France, there has lately arisen a ne master who already has hosts of imitators sure proof of greatness—I mean M. Ren Lalique. His work, although original, owe much of its charm to his appreciation of th ancient Greek chryselephantine work—that i say, the use of materials of little intrinsi value, but much artistic importance, used i conjunction with gold and silver. It is sup posed that the great statue of Athené in th Parthenon at Athens, was made of suc work—wood overlaid with gold and ivory and there are numbers of Byzantine jewel on which it is used. Ivory, pearls, enamels, horn, mother-of-pearl, and many other beautiful materials find a place in the work o M. Lalique and in that of his followers, among whom M. René Foy and M. Fouquet are perhaps the most distinguished up to the present.

England, so far, has remained constant to old themes, and then trusted to excellent workmanship and valuable materials. But the French departure is not without its effect already, as in some of our London shops can be seen beautiful and interesting developments which promise well for the future. Excellently designed, and often beautifully worked by hand, many of the new brooches, necklaces and bracelets are admirable, but there is also the tendency to reduplicate good designs in cast work, which is an unfortunate sign. No condemnation can be too strong for the popular designs of cycles, stirrups, golf clubs, tennis racquets and the rest, which still crowd our jewellers' windows, and which, however, richly carried out with pearls and jewels, will always be a blot upon our national taste in art.

Savage tribes have used for their ornaments tural objects easily worked.

The cultured nations of antiquity have nerally made their finest pieces of personal nament of gold.

During the period of the Renaissance gold d silver, coloured precious stones, and treous enamels were very largely used.

During the 19th century the diamond s particularly claimed the attention of wellers.

Slides Shown in Illustration of Pins and Brooches.

1. Roman bronze pin, with flattened and perforated ead. Found in London.

2. Roman bronze pin, with perforated head strung ith three rings. Found at Lymne, in Kent.

3. Ancient Irish bronze pin, with perforated head, which is threaded a coiled wire ring.

4. The "Arbutus Brooch." Celtic penannular rooch of silver gilt.

5. Irish annular brooch, "The Ardagh Brooch," f silver gilt, with Celtic ornamentation and enamelled osses. Found near Limerick.

6. The "Hunterston Brooch." Irish annular rooch, with rich Celtic traceries in gold, and set with mber, emeralds and blue stones. Found in Ayrshire.

7. The "Tara Brooch." Irish annular brooch, with ine Celtic traceries in gold, jewelled with amber osses, emamelled bosses and coloured jewels. At ne side is a chain of Trichinopoly pattern, on the inial of which are two glass heads in relief. Found ear Drogheda.

8. Roman bronze open circle brooch. Found in London.

9. Anglo-Saxon open circle brooch of bronze, with road outer rim, in which are two birds in the round. Found in Kent.

10. English 14th century open circle brooch of gold, set with sapphires and rubies.

11. English 14th century open circle brooch of gold, with eight bosses, set with rubies and hrysoprase alternately with figures of animals in the ound. The bosses are each capped with a pearl or apphire finial.

12. The "Glenlyon Brooch," of Scottish workmanhip. Open circle silver brooch, crossed with a ewelled band, and having two pins. The flat circle s adorned with pearls set in little turrets.

13. Anglo-Saxon bronze buckle (derived from open ircle brooch), with buckle plate bearing a pin, and et with inlays of flat garnets and green composition. Found in Kent.

14. Anglo-Saxon buckle of gold, set with flat garnets and blue glass inlays. Found in Kent.

15. Anglo-Saxon, solid-circle brooch of gold, set with geometrical inlays of flat garnets and blue composition. Found near Faversham.

16. Anglo-Saxon, solid-circle brooch of gold, found near Abingdon. With gold Celtic interlacings, and circles and lines closely set with small, flat garnets. Four large garnets are each set at the top of a white shell boss.

17. "The Hamilton Brooch." Anglo-Saxon, solid-circle brooch of gold, with very delicate cloisonné enamels, filigree work and pearls.

18. Anglo-Roman, solid-circle brooch of a slice of millefiori glass, set in bronze. Found in Monmouthshire.

19. Teutonic, solid-circle brooch of silver. In the centre, within a square, is a swastika in niello, within a border of interlaced lines. Found on the shore of the Mediterranean.

20. "The Lochbuy Brooch." Scottish, solid-circle brooch of silver, set with a large crystal in the centre, and Scottish pearls, each on a little turret. Made in the year 1500.

21. Renaissance brooch, cut in a fine emerald, bearing the head of Medusa in high relief, and surrounded by red and blue enamelled snakes intertwined, with diamond heads. Italian 16th century work.

22. French oval brooch. A cameo head of Diana, cut in a beautiful sardonyx, and set in an elaborate framework of enamelled gold. 16th century.

23. French oval brooch. A cameo head on grey onyx, set in a rich framework of enamelled gold.

24. Danish bronze brooch, with the outline of a triskele. Richly worked with interlacing straps and curves. Found in Sealand.

25. Roman bronze brooch, in the form of a swastika. Found at Brough in Westmoreland.

26. Pin, with long chain fitted into the head. Found among the lake dwellings in Lake Neuchâtel.

27. Roman fibula of silver, found near Folkestone. The same principle of construction as our safety-pin.

28. Boar's head brooch of bronze from Scandinavia, showing in its lines of ornamentation the constructive lines of the fibula last shown.

29. Ancient Boeotian fibula of bronze with swastika and other symbols engraved upon the arc.

30. Ancient Greek fibula of gold, with elongated point piece, on the end of which is a small winged lion in the round.

31. Roman fibula, with T-shaped top. Found in Britain.

32. Anglo-Saxon silver-gilt fibula, with enlarged top, jewelled with flat garnets. Derived from the last T-shaped fibula.

33. Scandinavian gilt fibula, with large rectangular top, all richly chased with interlaced ornament. Derived also from the T-shaped fibula.

Slides Shown in Illustration of Pendants.

1. Etruscan necklace, with large golden bulla pendant with repoussé figure of nymph.

2. Ancient Greek gold pendant, with large

repoussé disc and chains with flowerets and small vases. Found in Southern Russia.

3. Norwegian bracteate of silver gilt, with delicate gold filagree and black jewels.

4. Norwegian bracteates of silver gilt in the shape of ring crosses.

5. Anglo-Saxon pendant of gold, finely ornamented with filagree, and having in the centre a triskele of three birds' heads, set with flat garnets, the eyes "en cabochon."

6. Italian silver pendant, with the sacred monogram in Gothic letter in niello work. 15th century.

7. Italian pendant. An agate cameo, with delicate gold enamelled setting and pearl pendants. 16th century.

8. Italian pendant. Cameo portrait of a man cut in sardonyx, with richly designed setting of enamelled strap-work. 16th century.

9. Italian pendant. Antique cameo boy's head in high relief set in a broad edge of flower and leaf design, brilliantly enamelled. 16th century.

10. Italian pendant. Onyx cameo portrait of the Emperor Lucius Verus, in openwork setting of gold enamelled and set with small diamonds. 16th century.

11. Italian pendant in the form of a ship. Gold wlth cloisonne enamel and pendant pearls. 16th century.

12. Italian pendant of gold in two parts. The upper is nearly circular and closely set with rubies, the lower is drop-shaped and bears an enamelled group, in the round, of St. George and the Dragon—all enclosed within an edge closely set with rubies. 17th century.

13. French pendant, with antique cameo. Gold, with enamels and two small cameos set at each side. 16th century.

14. French pendant of gold in open work. The top is curiously ornamented with irregular silver bosses, in which are set diamond points. Below is an enamelled figure of the Virgin Mary, enclosed by enamelled scrolls and flowers. 17th century.

15. English pendant of gold, having a cameo portrait of Queen Elizabeth cut in a nicolo onyx. The setting is partly enamelled, and partly set with rubies and diamonds, with a diamond crown at the top. Below is a grape-cluster of pearls. Made for William Barbour, about 1560.

16. English pendant of gold, having a cameo portrait of Queen Elizabeth cut in turquoise, probably by Coldoré, and richly set in an elaborate framework of enamelled flowers, rubies and diamonds, with pearl drops. Formerly the property of the family of Wild. 11th century.

17. Spanish pendant. A dog, enamelled white with gold spots, standing in a scroll enriched with enamels, rubies and diamonds. From Saragossa. 16th century.

18. German pendant in form of a fish ridden by a merman. Enriched with enamels, rubies, emeralds and amethysts.

Miscellaneous.

LOCOMOTIVE PRIZE COMPETITION IN GERMANY.

The Association of German Machinery Engineers (Verein Deutscher Maschinen Ingenieure) of Berlin have, according to a German Trade Review, offered prizes of 5,000, 3,000, and 2,000 marks (£250, £150, and £100) for a constructive tracing of a locomotive able to pull a train of 180 tons in weight, on a level roadway, at a speed of 120 kilomètres per hour (74·5 miles) for a continuous run of at least three miles, the highest rate of speed not to exceed 150 kilomètres (93·2 miles) per hour. Complete sketches are further asked for railway carriages ensuring safe and quiet running at a speed of 150 kilomètres (93·2 miles) per hour, and fitted in such a manner, that in case of accidents they will afford the best possible protection to travellers. The ventilation, heating, and lighting of these carriages is to be specially considered, and great care paid to the brakes. The close of the competition is fixed for December 1, 1902. Any further particulars may be obtained by applying to the Secretary of the above Association, Herr Geheimer Kommissionrath F. C. Glaser, Lindenstrasse 80I., Berlin.

General Notes.

Trade of the Orange River Colony.—A comparison is made in the *Board of Trade Journal* between the value of the import trade of the colony during the first quarter of 1902 with the first quarter of 1901, from which it appears that the total imports in the first quarter of 1902 amounted to £363,823, while those of the first quarter of 1901 were only £89,503. The total value of the goods exported from the Orange River Colony in the first quarter of 1902 was £4,841, as compared with £2,287 in the first quarter of 1901. Of the former total £3,309 worth were sent to Natal, £1,307 to Cape Colony, and £100 worth to Basutoland, the remaining £75 worth going to the Transvaal.

Paper Buildings.—The *Paper-makers' Monthly Journal* reports that a Russian nobleman has upon his estate at Savinowka in Podolia a paper house of sixteen rooms, built in New York, at a cost of 80,000 roubles, and its architect declares that it will last longer than a stone building. Bergen, in Norway, has a church built of paper capable of seating a thousand people.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 12th July, too late for the results to be included in the Report of the Council. They lasted for 8 days.

The examination was conducted by Mr. Ernest Walker, M.A., Mus.Doc.Oxon., and Mr. Burnham Horner.

The system of examination was the same as that for last year. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play a piece, or portion of a piece, at sight, and to play certain scales.

In all, 413 candidates entered, and of these 397 were examined, a decrease of 153 as compared with last year; 3 of these took up two subjects, so that there were 400 examinations. Of these there were 336 passes and 64 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, and organ. 308 entered for the piano, 256 of whom passed and 2 obtained medals; 61 entered for the violin, of whom 54 passed; 2 entered for the violoncello, 1 of whom passed; 5 entered and 4 passed for the organ, and 2 obtained medals; 24 entered for singing, of whom 21 passed, 2 obtaining medals.

SHAW PRIZE FOR INDUSTRIAL HYGIENE.

THE HYDRAULIC MINING CARTRIDGE.

It has already been announced that the Benjamin Shaw prize has been awarded by the Council of the Society of Arts, to James Tonge, junr., F.G.S., M.I.M.E., of Westhoughton, Lancashire, for the Tonge hydraulic mining cartridge, an appliance for breaking down coal in mines without the use of explosives (*see ante*, p. 753). The following description of the cartridge, (Patents of A. J. Tonge, J. Tonge, junr., and E. Eaves), and the mode of working, has been prepared by Mr. J. Tonge, junr.

It has long been recognised amongst mining engineers, managers, and miners, that the use of explosives in coal mines is one of the most frequent causes of accidents. Naked lights and explosives have for many years been the sole cause of explosions of firedamp or coal dust, but with the great improvements made in safety lamps, one cause has been practically removed. The use of explosives, however, for breaking down the coal, still remains a serious drawback to the total prevention of these terrible occurrences. In addition to their being the chief cause of explosions, explosives are responsible for a large number of fatal accidents yearly, which, owing to the fact that only one or two persons at a time may be killed, do not cause a great amount of attention to be drawn to them. It is well known that the chief cause of death underground is due to falls of roof and sides—this being sometimes as high as 60 or 70 per cent. of the total underground deaths. Apart from explosions however, explosives are responsible generally for 20 or 25 per cent. of the underground accidents, as many as 60 to 100 men losing their lives annually, owing to accidents with explosives, in addition to the deaths due to great explosions with which the public is only too well acquainted.

The Hydraulic Mining Cartridge has been designed to supply the acknowledged need for a different method of bringing down the coal after it has been undercut, so that the coal may be got in the best possible condition. The use of high explosives for this purpose (apart from the element of danger) is not to be commended, as in consequence of their use the coal is shattered, dust is made, and coal is wasted.

Again, with greater depths, and increased distances and areas underground, the dangers and extent of explosions have proportionately increased, and this fact is becoming more firmly grasped every day. It occasionally occurs that when a new appliance is introduced into a mine, its qualities are quickly estimated merely from the effect upon the underground working expenses. Later on in this article it will be seen that ts effect upon the working cost is slight, and need not be considered, while its advantageous effect upon the selling price of the coal is striking.

DESCRIPTION.

The Cartridge.—This consists of a cylinder of steel (A), 20 in. long by 3 in. in diameter, and having eight small duplex rams (B, B,) fixed radially along it. By a suitable arrangement of passages (*n*, *n*) a communication is made between each of these rams, whereby simultaneous action can be obtained. By an ingenious contrivance a greater traverse is obtained by these rams (see Fig. 2) than the diameter of the cylinder would appear to allow.

FIG. 1.

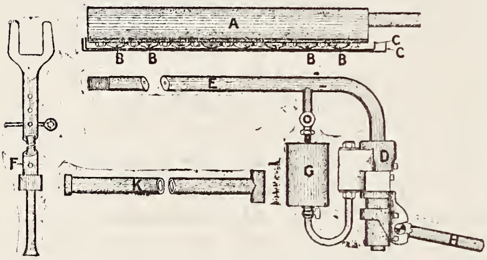
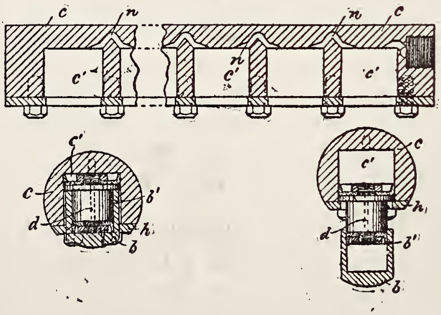


FIG. 2.



(*b*), Ram Shell; (*b'*), Outlet; (*c*), Cartridge Body; (*c'*), Ram Chamber; (*d*), Ram; (*h*), Stop Plate; (*n*), Water Passages.

This traverse is essential for the complete forcing down of the coal. Thin liners (C C) are used to prevent the rams cutting into the coal.

The Pump.—The cartridge is operated by a hydraulic pump (D) to which it is connected by a pipe (E). The pump is of special design, is mounted on an adjustable stand (F), and fitted with water tank (G). The water required for the whole of the operation is about 1½ pints, but most of this returns to the tank at its completion, and can be used again. At the commencement of the operation the small handle (H) is used, and when pressure has increased, extension handle (K) is slipped over it, and greater power is thus exerted.

A pressure of 3 tons per square inch can be reached, and this represents a total pressure on the coal of over 60 tons. This is found adequate in ordinary seams, and the standard sizes are made for this duty. Special cartridges are made for extraordinary conditions.

MODE OF WORKING.

Preparation. — After the coal has been under-cut, either by hand or coal-cutter, a hole 3¼ in. diameter is drilled about three or four feet deep into the coal (slightly less than depth of holing). This is done by means of ordinary machine and spiral drills. The hole is put in parallel with the roof, and as near as possible along the parting to which the coal ordinarily comes off, or just below it. It is then cleared out. The cartridge, with one or more liners, and having pipe and pump attached, is pushed to the back of the hole, and the pump is left in position for the attachment thereto of the stand, which is adjusted to the required height. The water tank is filled, and hung on the pipe, the rubber suction pipe coupled, and the taps turned. The coal sprags are all left in tight.

Operation. — The small handle is first actuated until pressure is reached, when the extension handle is attached. The pressure being fully on, the enormous power of the apparatus is soon apparent, for the coal is heard to be rumbling and cracking. This is allowed to continue until the back portion of the coal is broken off, after which the sprags are slightly slackened. By a continuance of the pumping, the pressure is brought to bear at the front of the faces, and continues to spread until the operation is completed. The sprags are then withdrawn. The whole process occupies about ten minutes.

ADVANTAGES.

It will be seen that the following results are obtained by using an apparatus of this kind:—

(1) Absolute immunity from explosions.

(2) No shaking of roof; and this in most cases is important.

(3) No damage to doors, &c., from vibration of air owing to "fast" shots.

(4) Least possible amount of dust.

(5) Absence of poisonous fumes.

(6) Dangers of "blown out" and "missed" shots avoided.

(7) Coal is larger when brought down, and is not shattered, consequently is not so readily broken in transit to the shaft and to the waggons.

(8) Coal can be brought down at all hours of the day, thus avoiding night work for such purposes.

(9) Result of three years working shows a distinct monetary gain to the employer.

ITS VALUE AS AGAINST EXPLOSIVES, CALCULATED FROM ACTUAL EXPERIENCE.

Hydraulic Cartridge.

On a longwall face, one man with one cartridge can make 25 to 30 "thrusts" per shift, or say 150 per week.

Working Cost—1 Cartridge, 150 Thrusts.

	£	s.	d.
Making holes by hand, 150 at 5½	3	8	9
Man, 6 days at 6s.	1	16	0
	£5	4	9

Value of Coal Got.

Hydraulic Cartridge.—150 "thrusts" give, say 300 tons.

300 tons of coal—	£	s.	d.
75 per cent. round (225 tons), at 10s. .	112	10	0
25 ,, small (75 tons), at 5s. ..	18	15	0
Extra value by reason of hardness and absence of dust, 300 tons at 6d. ..	7	10	0
Total ..	£138	15	0

Explosives.

On the same face a shotlighter would be required, but as he could probably do them in less time, this amount is deducted.

Working Cost—Explosives, 150 Shots.

	£	s.	d.
Shotlighter, 3 days at 6s.	0	18	0
Making holes by hand, 150 at 3d.	1	17	6
Cost of explosives, 150 at 4d.	2	10	0
	£5	5	6

Value of Coal Got.

300 tons—	£	s.	d.
65 per cent. round = (195 tons), at 10s.	97	10	0
35 per cent. small = (105 tons) at 5s...	26	5	0
Total	£123	15	0
Extra value of one cartridge per week....	15	0	0
,, ,, ,, say per annum..	£750	0	0

In this calculation an equal estimate is given for the amount of coal brought down at each time by cartridge and by explosives. In practice the cartridge brings down more per hole than explosives. It is also estimated in the calculation that there is a difference of 10 per cent. in round coal. In practice this is found to be the minimum difference. 15 per cent. or more of difference can be obtained in some seams.

I have given these particulars in order to show (1) the way in which the present methods of firing with explosives may be given up, and the new method commenced, and (2) that the use of the cartridge is not a loss to the employer, but with ordinary working may be a great gain.

Working of the Machines.

The following particulars refer to the working at two pits:—

The Chequerbent Collieries.—The Royal Arley and Deep Arley Mines.

The Atherton Collieries.—The Trencherbone Mine,

Hydraulic mining cartridges have been in use in these collieries for two years, and are in daily use at the present time. In one mine, the Royal Arley, 19,000 "Shots" (as we still call them) or "Thrusts" have been made by four machines during twelve months, ending December 31st, 1901, producing 40,000 tons of coal.

The section of the seam is as follows:—

3 feet ..	Good coal.	
4 inches .	Dirt.	Holing.
2 inches .	Coal.	

Throughout part of the mine, coal-cutters are used to hole the coal, undercutting to a depth of 5 feet 6 inches, and drill-holes for the cartridge are put in 5 feet deep, and placed 6 feet apart. Throughout the other part of the mine the coal is holed by colliers 4 feet deep, the drill-holes are made 3 feet 6 inches deep, and are placed 7 feet apart.

Four men are employed daily to operate the machines, there being always one spare machine. These men go round the faces while the men are at work and break down the coal for each miner whenever he has his place holed and his drill-hole put in. This arrangement differs greatly from that previously adopted at this colliery before the introduction of the cartridge, and from that adopted at most mines using explosives. Where explosives are used the shots are generally fired in the night, when all the men are out of the pit except those engaged in this work. It is a great advantage to the collier to have his coal broken down whenever he is ready for it; he is able to watch the operation himself, and see that the cartridge is doing its work properly, bringing down the whole of the coal which he has holed. This, of course, is impossible where explosives are used. It is necessary for him to be at a safe distance during firing, and if the charge is insufficient, some of his coal will be left unbroken; whereas, if the charge is too large, a serious accident may result, and it is very often impossible to exactly estimate the right amount of explosives to use. Again, the great distances which the coal has now to be hauled from the workings to the shaft, in consequence of the increasing depths of the coal seams, makes it necessary that the coal shall be got down in as sound and solid a condition as possible, so that it may not only be more valuable when it arrives at the surface, but in order that as little *coal-dust* as possible may be produced, the latter being now recognised as one of the most serious causes of explosions.

In the Deep Arley mines, machines are at work, the results being similar to the last, as the seam is the same, and the method of working exactly similar.

The Trencherbone mine is 4 feet thick, and the holing is in the dirt below the coal, being holed by coal-cutters in part of the mine to a depth of 4 feet, the drill holes being 3 feet 6 inches. These holes are not always the same distance apart. There is also a certain amount of holing by hand in this mine, but the depth and distances are the same as for coal-cutters.

The collieries are owned by the Hulton Colliery Company, Limited, who employ over 1,400 men underground, and whereas they had formerly 1,000 explosive shots per week, they have now entirely dispensed with shot-firing, the whole of the coal being now got down (where it does not fall naturally) by means of these machines.

Our whole idea in introducing the machines, was to do away with the use of explosives, using an appliance which would prove economical as well as safe. During the two years of their working, they have proved capable of resisting heavy pressures and continual usage without damage, and may now be considered a practical success.

The following is the extract from the "Reports of John Gerrard, H.M. Inspector of Mines for the Manchester and Ireland District (No. 6) for the year 1901," referred to above:—

"At the Hulton Collieries the hydraulic cartridges have been continuously in use in the Royal Arley, and have now entirely superseded explosives in that mine. The holes are put in 5 feet deep, 3¼ inches in diameter, every 6 feet, and follow the coal-cutting machines. The coals stick to the roof very much. One machine has been used in the Trencherbone Mine. Altogether during last year, 300 holes or shots were made in the Trencherbone, bringing down 600 tons of coal; in the Royal Arley 19,000 holes were put in, bringing down 40,000 tons of coal."

PERSONAL JEWELRY.

Sir George Birdwood, who took the chair at the delivery of Mr. Cyril Davenport's Cantor Lectures (printed in the last three numbers of the *Journal*), made the following remarks in moving a vote of thanks to Mr. Davenport at the conclusion of the series:—

Mr. Cyril Davenport was not only a full, ready, and exact man on the subject of these lectures, but was possessed by a strong instinctive appreciation of artistic jewelry, and similar objects of ornamental art, and while placing before us his far and wide gathered stores of information regarding them, in the simplest, clearest, and most effective manner, he succeeded also in inspiring us with his own delight in them: and the very best of the results of all knowledge was the enthusiasm it kindled in us. Charles Henault latins two well-known lines from Pope's "Essay on Criticism" for the motto of his "Abrégé de l'Histoire de France"; and they were the very lines, in Henault's translation of them, he would like to use for the motto of a volume of the collected lectures given by Mr. Cyril Davenport, at various times, before the Society of Arts:—

> "Indocti discant et ament meminisse periti."

The truly magical lantern slides prepared by Mr. Cyril Davenport for the illustration of his present lectures had forcibly demonstrated the absolute supremacy of Greece and India in the production of artistic jewelry. It was impossible to say of one of the modern Indian necklaces illustrated, and the best of four ancient Greek ones shewn on the screen, which was the finer and more exquisite masterpiece of the jeweler's art. Of course, the art being equal, Indian jewelry is always more interesting than Greek, because it still expresses in direct terms the religious symbolism which has always remained the originating impulse, and predominating motive, of Indian, and all Oriental jewelry, and other decorative arts. It was only when these symbols passed into Greece that they, for the most part, lost their religious significance, and were manipulated as mere ornamental "motives." In this way the *homa* tree, the "Tree of Life," or "Sacred Tree" of Anterior Asia, whether originally a pine tree, such as is figured on archaic Samian ware, and to this day on Spanish pottery and Levantine embroideries, or later the vine, and, last of all, the date palm, which on many of the "Nineveh marbles" continues to be cinctured with a twist of vine leaves; and again the "Lotus bud and flower" [Knop and Flower"] of Anterior Asia and Egypt;—these symbolical forms, in passing over into Greece, became, respectively, the honeysuckle and palmette "patterns," used for the mere architectural ornamentation of the corners of Doric cornices, apexes of pediments, horns [acroteria] of altars, and similar joinings and endings of building construction, which call for some decorative treatment that will at once emphasise them as constructive features and mask their mechanical baldness. These "patterns" in Greece possessed no intentional significance other than is due to their harmonious combination of curved lines of perfected beauty. There is no perfected beauty possible, or, what is the same thing, no perfected content in beauty, unless it be symbolical also of "the mysteries of the kingdom of heaven"; but perfected beauty in human art is in itself,—albeit unintentionally, if that be conceivable, on the artist's part,—but a finer, and nobler, if less direct symbol of the very same devout conceptions and emotions as those to which the crude Assyrian and Babylonian forms of the *homa* Tree, and Egyptian, and Assyrian, and Persian, and Indian forms of solar discs, and "wheels," [including the *swastika*, the original "motive," as Mr. Cyril Davenport has told us, of "the Greek fret], give suggestion, and more or less articulate expression. All great works of art, whether in music, painting, sculpture, architecture, or the industrial arts, always arouse the same devotional thoughts and feelings, as if their perfected beauty had breathed into them an indwelling, inherent, and essential, vitalising soul of benignity, purity, and candour, the divine grace of which moved those brought under their influence by a positive psychical sympathy, that is actual fellow-feeling, feeling in common, with them. He had often quoted in that Room a saying attributed to the Apostle of God:—"Every beautiful flower is an Alleluia!"; and recently he had been told by a distinguished Muslim on a visit to this country of a similar traditional saying of the Seal of the Prophets:—"Every creature of God, every elemental [cf: Dalton] atom, is an ascription of Glory to God!" And so it seemed to him that every human work of perfected beauty was animated and spiritualised by the adoring aspiration of its mute song of joy in its Maker:—"Dignare me laudare Te." This, indeed, is the final assay of surpassing genius in art, that through its mastery of an incommunicable style and distinction, it reveals the Author and Finisher of every perfect work as the first, last, and highest source of all that is good, and beautiful, and true. The beauty of holiness [in Semitic Art], and the holiness of beauty [in Greek Art], flow from this divine fountain head in one and the same undivided and indivisible stream.

A corollary from this, having especial pertinence to the decorative arts, is that, the artist who would find satisfaction in his work, should not attempt to seek it in vain efforts after the invention of novel conventional forms of ornamentation; for the human mind in this direction is limited, and its limits were long ago reached by the Chaldæans, Egyptians, Assyrians, and Babylonians; but should seek it where the Greeks found it, in the proportion, balance, refinement, and thoroughness, in a word, in the perfection of their handiwork. Perfection is the transcendental originality of all the arts; and it never fails to impress on them, whether in their noblest or their humblest productions, the sign manual of the artist's creative power.

Hindu jewelry was all symbolical. Mr. Cyril Davenport clearly recognises this as regards the diadems of kings and nobles. The turban and the helmet in India have nothing to do with the diadem. This consists of either a muslin fillet, or a velvet one, to which are fastened ouches of gold, set with various phylateric, prophylactic, talismanic, or amuletic stones, precious or otherwise. Both these fillets may be worn together,—and between them and the turban, or helmet are invariably fastened, one or other, and sometimes both, of the following insignia of royalty and State, viz.: the *kalgi*, or aigrette, formed either of egrets feathers, or those of the *homa* bird, or "phœnix," which in fact are the feathers of either "birds of Paradise," or the golden pheasant, tipped with gems, pearls, diamonds, emeralds, and rubies, one or other of them, or all together; and the *toru*, a form, in terms of gold, enamels, and gems, of the "Knop and Flower," or "Lotus bud and flower" symbol of the active and passive reproductive powers of nature, "the Jewel in the Lotus" of the celebrated Buddhistic formula:—"*Om mani* [Jewel] *padmi* [Lotus] *Hum**. Now this, very pertinently to coming events, goes to prove that the essential part of crowns and coronets is the circlet, and that the crimson velvet "Cap of State," stuffed into our English crowns and coronets in comparatively modern times serves no real purpose there, and only makes them look ungainly, and in some cases absolutely grotesque. How dignified, and graceful, and altogether artistic they may be made to appear without their obtrusive velvet stuffing, and preposterous topnot of shapeless bullion, can be judged from the numerous representations of the coronets of viscounts, earls, marquises, and dukes of the 14th, 15th, and 16th centuries, still surviving in England. The symbolical use of the aigrette in India may be compared with the custom, according to Herodotus [vii., 70], of the "Eastern Ethiopians" of attaching cranes' feathers to their shields; and [iv., 175] of the Macæ, of the Great Syrtis, of attaching ostrich feathers to their shields; and it all indicates that the profuse use by savages in the present day of feathers about their persons, and arms of warfare, is not meant to be ornamental, but talismanic.

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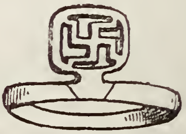
* *Om*, and its varient, *Hum*, are here, as is *Om* in the *gayatri* invocation of the Hindus, unmeaning sounds in themselves, that have in the transmutations of the ceaseless course of time, become invested with an import of the highest benediction and sanctification; but taken here in their association with the "Lotus bud and flower" symbol, which with the crossed triangles [cf.: Erasmus Darwin's "Loves of the Triangles"] represents in India the Lord Destroyer Siva, and his consort, Kali, in beatitude, there can be no doubt of their ithyphallic significance in the abysmal beginnings of the evolution of the religious sentiment amongst Aryan races of India.

The symbolic character of the discs and crescents worn by Indian women on their heads, is indicated by the names of the sun [*surya*] and moon [*chand*], and the other planets they bear. All the necklaces, zones, armlets, bracelets, and rings, worn by Indian women are symbolical, and, most of them are also, like our wedding ring, ritualistic. This is so even among the Muslimun, whose common names for necklaces, and other similar articles of jewelry is *tawiz*, "a fortress," "a refuge," *i.e.*, a phylactery, or prophylactic; *tilsam*, in the plural *talasim*, *i.e.*, a talisman; *hijab*, "cover," "a shelter," and, as a generic term, *hamail*, "suspended," our "amulet." Every necklace, zone, armlet, &c. [cf: Greek *periamma* and *periapton*, and Latin "præligamentum"], in fact, has suspended from it a case, of which ten or more denominations are known, containing it may be an extract from the Koran, or from some other sacred book, or certain mystical characters [cf.: "Ephesian letters," and "laminæ ignorabiliter literatæ"], phallic images, tiger's teeth, or claws, and such like articles, which are the actual *hamail*, *hijab*, *tilsam*, or *tawiz*. Rings are used as talismans by placing some mystic article within, or engraving some symbol on them; and the signet of its owner also confers talismanic power on the ring bearing it. There are certain necklaces worn by courtesans called "danglers," and "dallyers," but even these are worn as philtres ["love"-potions, cf: Greek *philtron hippeion*, "a horse bit"] rather than as idle ornaments. The only article of jewelry in use among Indian women known to him as non-symbolical was the high raised ring with a looking-glass fixed in the "chaton;" but it certainly is not ornamental. A great deal of nonsense has been written about it; but it was used simply as a speculum in certain sanitary ablutions, although when worn publicly it is everywhere the badge of the courtesan class.

Of couse as Hindoo women invest much of their wealth in jewelry, to this end heavily weighting thei anklets and [in Madras] bracelets, and as they, like other women, take a natural pleasure in the adornment of themselves therewith, the Greek term *keimelion*, "a treasure," and the Latin phrase, "mundus muliebris" [which includes perfumes, *khol*, and other cosmetics] both apply also to their jewelry; but, even after 150 years of the secularisation under the influences of British rule of the antique religious life of India, only in a secondary sense; and everywhere the Hindu jewelry of India still maintains its hieratic forms and their traditionary interpretation in full force. It was very remarkable that so little of the noble jewelry of the Greeks and Romans should have been, in a religious sense, so meaningless—"brave tinkling ornaments" [Isaiah iii., 18-21], and nothing more. Their lives were saturated with prehistoric superstitions, and largely preoccupied with the ritual of magical charms, such as the *kelema*, *epode*, *philtron* ["Phitra Thessala"] *alexeterion*, &c.; and although these were for the most part *alexipharmica*, *i.e.*, of the nature of medicinal prescriptions, often of the most opprobrious and revolting items, involving the practice of considerable jugglery, or *magganeia*, as it was termed, they recognised the *phylacterion*, and the *alexeterion*, when compounded in terms of jewelry, as an ornament, and their typical *thelketrion* was "the girdle [of flowered muslin] of Aphrodite." They were familiar also with a great variety of "charms," in the form of trinketry, or peasant jewelry, many of which survive to the present day in the defiles of the Appenines, and throughout Southern Italy, the most beautiful of them all being the silver "Sirens" [*Cavalli Marini*] of the lazzaroni of Naples. Then so much of the jewelry of Archaic Greece came from Anterior Asia, from Phrygia, from Phœnicia, even from Babylonia, and Assyria, and again from Egypt. The "ædicula," or *tawiz*, as a Muslim would call it, often fashioned as if a miniature "Mundus Cereris," or "Cista mystica," represented suspended from the neck of an Archigallus, or eunuch priest of Rhea Cybele, on a small bas-relief in the Capitoline Museum at Rome, and found in 1736, near the "Villa of the Antonines," is an instance. Another is a Greek ring of pure gold, attributed to the 6th century, B.C., in the possession of Mr. Cyril Davenport, which he has not shown us, but which he [Sir George Birdwood] hoped he might be allowed to use in illustration of his present remarks when they appeared in the Society's *Journal*. It was obviously, and wholly, symbolical, being nothing less than the *swastika*, set up, like a standard, above the circle of



the ring. In its motive, and modelling, and the manner of the proud setting of the *swastika,* and the purity of its gold, it was characteristically Hindu, of the Bombay bazaar of to-day, and but that he knew its history, he would have insisted on its being a Hindu [Saura] toe-ring. In apposition to it he would draw attention to an Indian toe-ring he himself always wore as a scarf-ring, representing the sun six months above, and six months below the equator. It was so Greek in its artistic "motive" that but for knowing its history he would have insisted on its being ancient Greek. Sir Caspar Purdon Clarke and Mr. Vincent Robinson, C.I.E., each possess a similar ring. It is the *symbolon* of the ideas we hold in common on Indian art. Again, there was the *baskanion,* including on the one hand the "Medusa's Head" or "Medusa *Mask*," and on the other the Latin "*fasc*inum," or "signum Satyricum"; publicly represented at Rome by the "Deus Mutunus Tutanus," or "D: Rediculus," of the Appian way, just at the spot where Hannibal turned back ["redierit"] on his march against the eternal City. It was none other in form and import than the *lingam* of the Canasese Lingaets, [the "ædicula" in which they carry the *lingam* is often not to be distinguished from the "Cista mystica" of the Greeks and Romans] of Southern India. But the later Romans knew no more of the symbolism of this immemorial jewel than ourselves, who still hang it, in the form of "coral and bells" round the necks of teething children. Mr. Cyril Davenport's illustration of the "pendant" of an Etruskan necklace, almost suggests that the Babylonian seal cylinder was used as the "fascinum" on its first becoming known to the people of the Mediterranean countries. Finally—because of the limits of time and space—the "bulla" worn by the Roman boys up to their adolescence, although in latter times it lost much of its ritualistic quality, as evidenced by the phrase "bulla dignus," "frivolous," "flippant," "childish," when wrought of gold was identical in form, as in its original symbolism, with the concave disc of gold worn on a thread round the neck by Hindu boys from the sixth month after birth, until the fifth, sixth, or eighth year of their age. With the "fascinum" and the "prætexta" [the coloured selvedge of the "toga," found on all Hindu robe and turban, and waist cloths], it was introduced into Latium from Etruria.

A very interesting ornament, analogous in its ritualism to the "bulla," was the silver fig leaf, modelled from the *Ficus religiosa* or "Sacred Fig Tree," worn in certain districts of India by unmarried girls as their only article of attire. It is indeed to be found in similar use in every oriental country from Morocco to the Indian Archipelago.

Then certain forms of jewelry denote a married woman, others a widow; and again, gold jewelry among the Hindus denotes certain castes, or certain classes of these people, and silver other castes and classes. Mahomet permitted, or rather did not prohibit, the use of gold jewelry by women [he expressly indulged them in scents], but he forbade its use by men. This prohibition is regarded in India only by the strictest Muslimun, but every Muslim in India wears, in imitation of Mahomet, a silver signet ring on the little finger of his right hand, incribed:—"— the Servant [of God]." Mahomet's was inscribed: — "Muhammad, the Messenger of God;" and he wore no other article of jewelry. This rivalry between gold and silver jewelry is probably to be traced ultimately to the rivalry in Anterior and Southern Asia between the worshippers of the Moon God, Sin [after whom Mount Sinai is named], and such Sun Gods as Bael [Belus]; and the most modern phase of the rivalry was the controversy which raged throughout Europe and America some years ago over the problem of bimetallism! There never would have been a silver currency in Asia but for the wide prevalence in parts of Mesopotamia, and of Arabia, of Moon worship. Throughout Islam a ring worn in the left ear indicates a slave. Also, jewelry bequeathed to a family is not divided among them under legal rules, but by an amicable arrangement among themselves; and this is done in consideration of the great difficulties presented in the just valuation of family jewelry. What we call "posies," *i.e.,* "poesies," on rings are in India, either of a religious or a gravely didactic character. Most of the former are well known; among the latter I have observed:—"Straightforward conduct is always pleasing to God; no man was ever lost in the straight road [of duty]"; and:—"An hour of righteousness is more than a lifetime of prayer."

Skeat derives the English word "jewel," in Middle English *jowel,* through the Old French *jouel,* which later became *joyau,* meaning a "little joy," from the Latin "gaudium;" and he compares the Spanish *joya* "a jewel" and *joyel* "a trinket;" and Italian *gioja,* "joy," and a jewel," and *giojello* "a trinket." Now the Arabic [and I presume Phœnician] for jewel is *jauhar,* plural *jawahir;* and he [Sir George Birdwood] could not help suspecting that the Arabic and modern European words for jewelry were connected. Surely there could be nothing surprising, etymologically, if the Dutch jewel, German juweel, and their French and other Romance kindred cited by Skeat, all came from the Arabic *jauhar* or *jawahir,* through a form *johal* or *jowahal;*—the Arabic itself coming from the old Persian *gauhar* [modern *marwarid*], meaning a pearl, emphatically of Bahrein. It is hard to believe in an intermediate form "gaudiellum" between "gaudium" and *jouel*; while "jocalia," attested in a 9th century gloss with the sense of "toys," is not found with that of jewels before the 12th. Gaudium is cognate with the Greek *gauros* "proud," and Sanskrit *gauras* "yellow," "bright" [cf: Gauri, the yellow-haired consort of Siva]; and we derive directly from the Latin word the English words and phrases, gawd, a jewel, in the sense rather of a trinket, gaudy-beads, the large beads on a rosary, and gaudy-days, college feast days. Pliny's phrase, xx. Prœm: "adamas opum gaudium" has been rendered, "the diamond is the jewel of opulence," but it means simply "the pride" of luxury. Compare xvi., 25 (40): "flos gaudium arborum"—"the flower is the pride of trees" or, here, it well might be their "delight," their "joy."

THE LEATHER GLOVE INDUSTRY IN THE UNITED STATES.

The manufacture of leather gloves and mittens is now for the first time made the subject of a special report by the United States Census Office, although the industry has been of commercial importance in the country for nearly a century. In 1900, there was a capital of £1,825,000 invested in the manufacture of leather gloves and mittens in the 397 establishments in the United States. This sum represents the value of land, buildings, machinery, tools and implements, raw material, &c., but does not include the capital stock of any of the manufacturing corporations engaged in this industry. The value of the products is returned as £3,409,999, an increase of 68·7 per cent. in the period 1890-1900.

The manufacture of gloves in the United States dates from about the year 1760, when Sir William Johnson, chief agent of King George with the North American Indians, brought over from Scotland many families as settlers on his grants. Many of these settlers had been glove makers and members of the Glove Guild of Scotland, and brought with them glove patterns and proper needles and threads for glove-making. The first gloves and mittens were used chiefly by the farmers and woodchoppers as a protection for the hands when engaged in the rough and laborious work incident to their occupation. The industry received a decided stimulus during the Civil War, as large quantities of gloves, especially gauntlets, were required for military service. During the early period of the industry the Indian process of tanning was exclusively employed. The distinguishing feature of this process was the use of the brain of the deer, which insured a durable, as well as a soft and pliant leather. Somewhat later an attempt was made to substitute the brain of the hog, but the results were not entirely satisfactory, as it lacked certain essential properties possessed by the deer brain.

At the present time the sheep and lamb skins used are received in what is termed "salt pickle," which is applied to the skin after the removal of the hair. As soon as received they are thoroughly washed, to remove the salt and to extract the pickle, after which they remain in an alum bath for nearly twelve hours. They are then staked, a process which involves the stretching or drawing of the skin over a thin, round-faced iron attached to a piece of wood about the height of a man's knee. This is done partly by the hand and partly by the knee of the operator. The process is generally termed "knee staking," in contradistinction to a similar process known as "arm staking," to which the leather is subjected after reaching the glove factory. The skins are then dried in the open air or in drying rooms, the temperature of which is regulated according to the nature of the skin and the time required to dry it, after which they are again carefully washed, slaked, and dried. As a rule the skins are next sorted according to size and quality, and are then submerged in an egg bath consisting of a preparation of ten parts of salt with ninety parts of egg yolk. By revolving the skins in a drum the egg yolk is thoroughly absorbed, and the leather becomes soft and pliable. They are next coloured by placing them flesh side down on zinc or lead tables, and applying the colour with a brush. After the colour is set and the skins are thoroughly dried, they are dampered, rolled up in bundles, flesh side out, and stored away to season for a varying length of time. The milling of oil-dressed skins involves a somewhat different process. After the skins are soaked in vats they are scraped to remove the grain, then dried into parchment, soaked in water and milled in oil. The oil and natural grease are removed by the agency of soda ash, the skins being repeatedly dried during these various processes, after which they are subjected to the braking machine, and then staked with a blunt tool, which renders them pliable. They are then put on the "buck tail," or emery wheel, and cut down for a face, and then returned to the water for a clean scouring, wrung out and dried, spread upon the grass for the night dew to bleach, and again staked, finished and smoked or coloured, after which they are ready for the glove maker. As soon as the skin is received by the glove-maker it is immediately staked by the hand-stake, which consists of two upright and two horizontal bars, one of the latter being moveable to admit the skin, which is held in position by a wedge inserted at the end of the bar. The stretching is then done by pressing over the skin so placed a blunt iron like a spade, having round corners and a handle which fits under the arm. The oil-dressed skins are then split even in a belt-splitting machine, and the kid skins are shaved either by "mooning," or by placing them on a marble slab, with the flesh side up, and shaving the surface with a broad chisel, or so-called "dowling-knife." By this process the skin is reduced to the desired thinness, and the inequalities of the flesh side are removed. "Mooning" is performed with a round steel, shaped like a plate, and having the centre cut out, and a handle placed across the opening; the skin is then hung on an elastic pole, and the moon-shaped knife is drawn over the flesh until the desired result is secured. The skin is then ready to go to the cutters, of which there are two classes, the block and the table cutter, each class having as a rule separate rooms. The block cutters are engaged in cutting the cheaper and coarser grades of gloves. The skin is placed on a block made of hard wood planks placed on end and bolted together, and the die of the required shape and style is placed carefully on the skin, and given a blow with the maul. In the table cutters' room, tables instead of blocks are used. The skin is damped, then stretched over the end of the table until it will stretch no more, and then cut off the length of the glove, next stretched to the width and cut off, after which the fingers and openings are put in with the die and press.

A table-cut glove, inasmuch as it is more elastic, and will conform to the shape of the hands, will give a much better fit than a glove cut on the block. In the cheaper and heavier grades, however, a perfect fit is not absolutely essential. The table cutters in the glove factories of the United States are of many nationalities, including French, English, German, Swedish, and in fact, they include representatives of every country in which gloves are manufactured. The foreign cutters are, so to speak, born in the glove industry, as for generations their families and relatives have obtained a livelihood by cutting gloves. To be a good table cutter requires an apprenticeship of at least three years, and even after this period not more than one out of three can be considered an excellent workman. The fingers of the cutter must possess the habit and nimbleness which can only be acquired by long practice. He must make a careful examination of each skin, and so shape it that he may get the greatest number of pairs of gloves, and yet avoid the flaws.

From the cutters' room the leather, which has assumed the shape of the glove, is sent to the "silkers," who embroider the back, and then to the "makers." Some make the gloves, that is they sew the fingers and put the thumbs in; others, called "welters," are engaged in welting or hemming the glove round the edge of the wrist,—still others called "pointers" work the ornamental lines on the back. After the glove has reached this stage of completion, the fourchettes and the thumb are put in place; the back is then embroidered and the end of the silk is pulled out and tied, and the glove closed by beginning either at the upper end of the long seam and sewing towards the little finger, or at the end of the under finger and finishing with the long seam. The glove is now ready to be bound, hemmed or banded, the button hole made or the lacings or fastener adjusted.

Each maker has his particular part of the work to do, and before a glove is finished it must pass through a number of hands. After the gloves are made, they are drawn over metal hands heated by steam, a "laying off" process as it is termed, and by means of which the glove is shaped and given its finished appearance. The gloves are now ready for inspection, and are assorted according to grades and sizes, and finally forwarded to the stock room, ready for shipment.

POST OFFICE, 1902.

The Postmaster-General has just issued the forty-eighth annual report of the Post Office for the year ended March 31st, 1902, which contains the following statistics of the various departments of work:—

Postal Packets.—It is estimated that the number of postal packets delivered in the United Kingdom during the year was as follows:—

—	Number.	Increase per cent.	Average Number to each Person.
Letters	2,451,500,000	5·5	58·9
Postcards	444,900,000	6·2	10·7
Book Packets and Circulars	766,200,000	4·6	18·4
Newspapers	169,800,000	1·2	4·1
Parcels	86,600,000	6·9	2·1
Total......	3,919,000,000	5·2	94·2

The number of undelivered packets were:—Letters, 10,183,866; Postcards, 1,757,081; Book Packets and Circulars, 11,523,272; Newspapers, 715,285; Parcels, 242,472.

The number of undelivered letters is larger by 3,500,000 than the figures for five years ago. Out of 10,000,000 letters undelivered, nearly 9,000,000 were re-issued to corrected addresses or returned to the senders.

The number of undelivered letters from places abroad (not including 27,250 from the South African Field Force) returned unopened to the countries of origin was 417,900, an increase for the year of 10·8 per cent. The letters returned as undelivered to this country from places abroad numbered 596,300, an increase of 4·5 per cent.

The letters have increased at a higher rate than for many years past, excluding the two years after the Jubilee reduction of postage. The increase in the rural districts was as much as 6·78 per cent.

The increase in the number of postcards, which was 4·7 per cent. during the two previous years, rose last year to 6·2 per cent. Pictorial postcards are no doubt responsible for a large share of this rise. About 65 per cent. of the whole number of postcards passing through the post are private cards.

The increase in the number of book packets and circulars was nearly confined to those delivered in England, outside London, and in Ireland. In Scotland there was an actual falling off by 2·3 per cent.

On the other hand, the increase in the newspapers is in respect of those delivered in towns. The growth of Parcel Post business has again been very large.

The number of letters registered in the United Kingdom was 18,800,313, an increase of 6 per cent. over the number in the previous year. The number of parcels registered was 1,079,541, the increase over the number in 1900-01 being 14·8 per cent.

The number of registered letters and letters containing property which reached the Returned Letter Offices during the year was 358,300, an increase of 21·6 per cent. The number of inland registered letters alone rose from 72,600 in 1900-01 to 115,400 during the past year, an increase of nearly 60 per cent., due largely to the use of the post for a trade in cheap jewellery.

The property found at the Returned Letter Offices in undelivered letters included £18,231 in cash and bank notes, and £650,298 in bills, cheques, money orders, postal orders, and stamps. The letters posted without address and containing property numbered 3,782. The contents included £179 in cash and bank notes, and £3,434 in cheques, &c. The articles found loose in the post numbered 85,640, and included coin to the amount of more than £1,000, and cheques, &c., to the value of more than £6,000. A half-sovereign, which had evidently been used to seal a parcel, was found to be still adhering to the wax on the arrival of the parcel in London.

Parcel Post.—The Foreign and Colonial Parcel Post has been extended to German Post-offices in China, to Portuguese East Africa, to certain Post-offices of the Ottoman Empire both in Europe and in Asia, and to Agencies of the Japanese Post-office in Corea. The system of parcel insurance has been extended to the Gold Coast, to Liberia, to Agencies of the German Post-office at Peking, Tientsin, and Tongku, to Malta and the Straits Settlements (*viâ* France), and to Erithræa. A higher limit of insurance for parcels has been arranged with Labuan.

The total number of parcels sent to and received from places abroad during the year was 3,417,817. These figures show an increase of about 9 per cent. on those of the previous year. As in the two past years, the outward parcels have increased in a larger ratio than the inward parcels, though the difference is less marked. There is again a great increase in the number of parcels forwarded to the Cape Colony, while those sent to Natal have materially decreased. Other large increases occurred in the numbers sent to Germany, India, Italy, Malta, New Zealand, Switzerland, and the West African Colonies. On the other hand, there was a falling-off in the number of parcels received from Costa Rica and in direct mails from Norway and Sweden.

Money Orders.—There has been an increase of every class of money order business.

The increase in ordinary Inland Money Orders (5·1 per cent. in number and 6·8 per cent. in amount) is again exceptionally large, and is due partly to the use made of such orders by the military authorities for paying soldiers on furlough and militiamen on demobilisation and by the Crown agents for the colonies for paying allotments to the families of the South African Constabulary. The telegraph money order system is fast growing in popularity, and is proving useful in unexpected directions. It was noticed, for instance, that one London firm remitted to its country branches by this means £20,000 in seven months.

The average amount of an ordinary inland money order was £3 0s. 4d., or 11d. more than last year, and of a telegraph money order £3 0s. 2d., or 1s. less than last year.

Nearly one-half of the Government orders were on War Office account. Since August, 1901, £85,340 have been paid in this way to members of the Imperial Yeomanry. The Admiralty have also since April, 1901, used Government money orders for making quarterly payments to the men of the newly-formed Royal Fleet Reserve.

Postal Orders.—The number of postal orders issued to the public during the year was 90,687,404, representing £32,724,681. The produce of the commission on these orders was £385,605. The orders have increased 6·20 per cent. in number, and 9·51 per cent. in amount during the year.

The value of the stamps affixed to postal orders by the holders during the year was £172,177.

Post Office Savings Bank.—During the year ended the 31st December, 1901, 15,018,645 deposits were made, the total sum deposited being £41,452,051; the withdrawals numbered £5,748,624, the total sum withdrawn being £39,890,043. The largest amount ever withdrawn in one day was £235,355, on the 17th December. The sum of £3,281,263 was credited to depositors as interest; and the total amount due to these at the end of the year was £140,392,916. The amount added in the year to the total credit of depositors again fell from £5,431,040 in 1900 to £4,843,271 in 1901. On the other hand, the amount of Government stock held by depositors in the Bank increased during 1901 by £2,300,000.

Telegraphs.—The number of telegrams sent over the wires of the Department during the year was 90,432,041, the increase over the figures for 1900-01 being ·95 per cent.

The estimated value of the railway free telegrams is £54,986, and of Government free telegrams £25,995, making a total of £80,981.

Including 13 at railway stations, 272 additional telegraph offices were opened during the year. Of these offices, 180 were opened under guarantees provided by public bodies or private persons, the Post Office undertaking to bear half the amount of any deficiency.

There are now 11,784 telegraph offices in the United Kingdom—9,430 at post-offices, and 2,354 at railway stations. As compared with the number for the year 1896-97—five years ago—this shows an increase of 1,601, or 15·7 per cent.

Telephones.—On the 31st March last, the number of Post Office trunk wire centres was 328, an increase of 16 in the year. The trunk circuits in use numbered 1,165, and contained about 98,000 miles of wire. Out of the capital sum of £2,300,000 authorised by Parliament for the purchase and development of the trunk system, the expenditure up to 31st March last was approximately £1,896,649. The expenditure during the year was approximately £201,570.

The total number of trunk wire conversations during the year was 10,080,716, or, reckoning each conversation as involving at least two spoken messages, a total number of 20,161,432 messages (an increase of 12·31 per cent. over that of the preceding year). The gross trunk revenue was £238,720, as compared with £211,209, and the average value of each transaction was 5·68d., or practically the same as in the preceding year.

Post-office Buildings.—One hundred and thirty-two Post-offices belonging to the Crown have been opened during the year, of which 67 are new buildings specially erected for the purpose. Twenty-nine Post-offices have been enlarged or improved, and 66 are in course of erection and enlargement.

The expenditure out of the Post Office votes for the acquisition of sites and buildings during the year amounted to £146,157, as against £114,608 in 1900-01. The expenditure by the Commissioners of Works and Buildings on buildings for the Post Office amounted to £203,464 in Great Britain and £18,880 in Ireland. The corresponding figures for the previous year were £205,479 and £24,391.

Staff.—The number of persons on the establishment of the Post Office, including all Head and Sub-Postmasters, is 97,785, of whom 16,282 are women. The number added during the year was 3,653.

In addition to the above, there are 81,417 persons filling unestablished situations (some of them employed only for an hour or two daily), of whom 20,267 are women. The number added during the year to the unestablished force was 2,358.

The total number of persons employed in the Post Office is thus 179,202.

The number of women who retired on marriage in 1901 was 201, with an average age of 27, and an average service of 9·7 years.

NEW SOUTH WALES SHIPPING TRADE.

The shipping trade of New South Wales continues to progress under Federation, and Sydney to maintain its reputation as the leading port of the Commonwealth, the annual increase of tonnage remaining undiminished in 1901. In that year the shipping trade of the State represented 6·21 tons per head of population, against 5·23 tons in 1897, and 4·32 tons in 1893. The total tonnage in 1901 was 8,521,234, against 6,744,431 tons in 1897, and 5,193,328 tons in 1893. Of the total tonnage in 1901, 7,176,652 tons were under the British flag, and of the remainder France contributed 231,377 tons, Germany 396,379 tons, Norway and Sweden 98,000 tons, Japan 114,210 tons, United States 395,185 tons, other nationalities 109,431 tons. The sailing tonnage formed about one-eighth of the whole. These figures do not include ships of war, cable-laying vessels, yachts, or vessels trading between ports of the State. Of 2,062 Australian Commonwealth vessels leaving the State ports, 1,760 cleared for ports in other States, 194 for New Zealand, 3 for the United Kingdom, 42 for other British possessions, and the remainder for the Caroline Islands, China, France, Hawaii, Marshall Islands, Java, New Britain, New Caledonia, New Hebrides, the Philippines, South Sea Islands, and United States. The number of British vessels, other than Australian, leaving New South Wales ports was 886, representing a tonnage of 1,865,454, of which 216, tonnage 386,704, cleared for Commonwealth ports; 110, tonnage 204,032, for New Zealand; 117, tonnage 573,256, for the United Kingdom; 121, tonnage 255,923, for other British possessions; and 262, tonnage 445,540, for other countries. Of vessels leaving New South Wales under other than the British flag there were 694, tonnage 1,113,692, their respective destinations including Austria, Belgium, France, Germany, Greece, Italy, Netherlands, Norway, Russia, United States, Argentine Republic, Brazil, Chili, Ecuador, Mexico, Peru, Nicaragua, Panama, Uruguay, Asia Minor, Egypt, China, Cochin China, German East Africa, Hawaii, Java, Japan, Madagascar, Philippine Islands, Reunion, Caroline Islands, Kerguelan Island, Marshall Island, New Britain, New Caledonia, New Hebrides, and South Sea Islands. The entries from all ports were about the same as the clearances, showing the extent and diversity of the shipping trade of the State, of which comparatively few people in Europe and America seem to be aware.

The port of Sydney enjoyed the lion's share of the trade, the number of vessels entered and cleared during 1901 being 3,328, representing a tonnage of 5,413,677. The number of vessels entered and cleared at Newcastle was 1,816, with a tonnage of 2,609,861. Many of the vessels enter the port in ballast and clear with cargoes of coal, the largest quantities being shipped to the United States and South America. Wood continues to be the principal material employed in local ship building, only two out of the twenty-three vessels constructed in 1901 being of iron. During the last ten years there have been considerable reductions in over-sea cargo rates by steam vessels, but those by sailing ships have either remained stationary or show an advancing tendency. The number of passengers by oversea sailing vessels is becoming smaller from year to year, owing to the time occupied by the voyage, and the great decrease in the rates of steamer fares. Single first-class fares from Sydney to London are, however, quoted at from £35 to £40 by most of the larger vessels. The general safety of the New South Wales coast is illustrated by the fewness of disasters compared with the large number of voyages made. In 1901 there were less wrecks or disasters, none of over-sea vessels, the value of the vessels and cargoes being under £25,000. Only nine lives were lost, the crews and passengers in all save a couple of cases making good their escape. In most instances the disasters were traceable to shortcomings on the part of the master or mate. Of 135 wrecks or disasters during the last ten years, only 17 were of vessels of over 500 tons; and of 1,287 crews and passengers only 178 were lost, principally in connection with a couple of steamers trading to the East. The dock accommodation in Sydney harbour has become considerably increased during the last few years. There ara two graving docks belonging to the State Government, one having a length of 600 feet by a width of 84 feet; the other having a length of 450 feet by a width of 50 feet. There are two large private docks; one of these is 575 feet in length, and when completed will be 765 feet in length. Also four floating docks, a pontoon, and three patent slips. There are a couple of patent slips at Newcastle, and Government graving docks on the Tweed, Richmond, Clarence, Macleay, Manning, and Shoalhaven Rivers.

HORSE BREEDING IN GERMANY AND FRANCE.

It is only during the last few years that special attention has been given to horse breeding in Germany. Careful inquiries into the subject show that the system so far followed, does not meet the requirements of the army, or of the public generally. While in France, Belgium, and Denmark, horse breeding is said to pay farmers—especially small farmers—better than any other branch of industry, this is not the case in Germany, where many complaints are heard with regard to Government rules, which are said to be adverse to a favourable development of horse breeding. In consequence, the importation of foreign bred animals is continually increasing. In 1900, France exported 3,000 horses more than she imported, but Germany had to import 90,000 more than she exported. In view of these facts, the German Foreign Office sent an expert to northern France to investigate horse breeding, and according to Consul Hughes, of Coburg, his report states that after the Franco-German War (1870-71) French horse breeding was nearly ruined, and in 1874 the French Chamber of Deputies had to grant money to gradually re-establish it, and the success now attained proves the wisdom of the act. In France, 18,000,000 francs (£720,000)—of which the State alone contributes 2,355,570 francs (£94,220)—are spent every year in the improvement of horse breeding, while in Germany the Government spends only a little more than 300,000 marks (£15,000), and gives a number of prizes for races. Among the causes which have contributed to the advancement of horse breeding in France, is the fact that the whole management is under the charge of a specially appointed staff (in Germany it rests in the hands of one man). At the head of the French staff, under the supervision of the Minister of Agriculture, is the Director-General, with his office in Paris. Under him are six inspectors-general, and other *employés* who purchase and care for the stallions for the State. Another useful institution is the stud school at Le Pin, where the training of *employés* is finished. The "breaking-in schools" (*écoles de dressage*) are of great assistance in the rearing of half-bred horses. The better class of coachmen and grooms often come from these schools. The skilful way in which the Paris hackney coachmen handle their horses, and make their way through the crowded streets — due less to the use of the whip than to attention — should, it is said, be credited to a great extent to the beneficial influences exercised by the "écoles de dressage." The forming of horse breeders' unions in Germany, a rational selection of stud horses, and some method of helping private persons or associations to keep the necessary stud of animals is advised. France had, in 1900, 3,087 stallions belonging to the State, and 7,480 to private persons; while in the kingdom of Prussia only 2,924 stallions belonged to the State, and 1,599 to private persons; and it must be remembered that Prussia is doing more than any other German State to improve the horse breeding establishments.

General Notes.

INSTITUTE OF SANITARY ENGINEERS. — The Chairman of Council, Mr. F. J. Rayner, will deliver his opening Sessional Address, on Wednesday, September 10th, 1902, at 7 p.m., at 19, Bloomsbury-square, W.C.

THE FORESTS OF PRUSSIA.—Of the 86,151,083 acres of land in Prussia, 20,435,499, or 23·7 per cent. are occupied by forests and orchards. More than one-third of the area of Hesse, Nassau, Hohenzollern and Brandenburg is covered with forests. In Schleswig Holstein, on the other hand, forests occupy less than one-fifteenth of the area of the province. The ownership of the forests is as follows:—State property, 6,319,072 acres; Crown property, 178,950; forests partly owned by the State, 2,805; communal property, 2,727,109; forests owned by institutions, 242,089; forests owned by companies, 584,216; private property, 10,381,258 acres. The areas occupied by deciduous trees and trees of the pine family are respectively 6,317,446 acres, or 30·9 per cent., and 14,118,054 acres, or 69·1 per cent. Of the centre area of the kingdom, 7·3 per cent. is occupied by forests of deciduous trees, and 16·4 per cent. by those of the pine family. These forests yielded in wood since 1900, 861,000,000 cubic feet, in addition to 2,709,000 cubic feet of oak tanning bark, 3,408,000 cubic feet of osiers, and 1,809,000 cubic feet other of wood, a total of nearly 869,000,000 cubic feet.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts offer the Fothergill Prize of £50 and a Silver Medal for a paper on "Existing Laws, By-Laws, and Regulations relating to Protection from Fire, with Criticisms and Suggestions." The paper should consist of about eight to ten thousand words, and be written with a view to its being read and discussed at an ordinary meeting of the Society.

Papers submitted for the Prize must be sent to the Secretary on or before 1st of October, 1902. Each paper must be typewritten, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges no paper deserving the full award is sent in.

APPLIED CHEMISTRY, ENGLISH AND FOREIGN.[*]

The Diplomatic and Consular reports published from time to time by the Foreign Office are usually too belated to be of much use to business men, but they sometimes contain information concerning what is done in foreign countries which affords food for reflection. One of these reports, issued a year ago, gives a very good account of the German arrangements and provisions for scientific training, and of the enormous commercial demand for the services of men who have passed successfully through the universities and technical high schools, as well as of the wealth that has accrued to Germany through the systematic application of scientific proficiency to the ordinary business of life.

Taking these points in their order, I have thought it a matter of great interest to obtain a comparative view of chemical equipment in this country and in Germany, and I am indebted to Professor Henderson of Glasgow, who last year became the secretary of a committee of this Association of which Professor Armstrong is chairman, for statistics referring to this country, which enable a comparison to be broadly made. The author of the consular report estimates that in 1901 there were 4,500 trained chemists employed in German works, the number having risen to this point from 1,700 employed twenty-five years earlier. It is difficult to give perfectly accurate figures for this country, but a liberal estimate places the number of works chemists at 1,500, while at the very outside it cannot be put higher than somewhere between 1,500 and 2,000. In other words, we cannot show in the United Kingdom, notwithstanding the immense range of the chemical industries in which we once stood prominent, more than one-third of the professional staff employed in Germany. It may perhaps be thought or hoped that we make up in quality for our defect in quantity, but unfortunately this is not the case. On the contrary, the German chemists are, on the average, as superior in technical training and acquirements as they are numerically. Details are given in the report of the training of 633 chemists employed in German works. Of these, 69 per cent. hold the degree of Ph.D., about 10 per cent. hold the diploma of a technical high school, and about 5 per cent. hold both qualifications. That is to say 84 per cent. have received a thoroughly systematic and complete chemical training, and 74 per cent. of these add the advantages of a university career. Compare with this the information furnished by 500 chemists in British works. Of these only 21 per cent. are graduates, while about 10 per cent. hold the diploma of a college. Putting the case as high as we can, and ignoring the more practical and thorough training of the German universities, which give their degrees for work done, and not for questions asked and answered on paper, we have only 31 per cent. of systematically trained chemists, against 84 per cent. in German works. It ought to be mentioned that about 21 per cent. of the 500 are Fellows or Associates of the Institute of Chemistry, whatever that may amount to in practice, but of these a very large number have already been accounted for under the heads of graduates and holders of diplomas. These figures, which I suspect are much too favourable on the British side, unmistakably point to the prevalence among employers in this country of the antiquated adherence to rule of thumb, which is at the root of the backwardness we have to deplore. It hardly needs to be pointed out to such an audience as the present that chemists who are neither graduates of a university, nor holders of a diploma from a technical college, may be competent to carry on existing processes according to traditional methods, but are very unlikely to effect substantial improvements, or to invent new and more efficient processes. I am very far from denying that here and there an individual may be found whose exceptional ability enables him to triumph over all defects of training. But in all educational matters it is the average man whom we have to consider, and the average ability which we have to develop. Now, to take the second point—the actual money value of the industries carried on in Germany by an army of workers both quantitatively and qualitatively so superior to our own. The consular report estimates the whole value of German chemical industries at not less than fifty millions sterling per annum. These industries have sprung up within the last seventy years, and have received enormous expansion during the last thirty. They are, moreover, very largely founded upon basic discoveries made by English chemists, but never properly appreciated or scientifically developed in the land of their birth. I will place before you some figures showing the growth of a single firm engaged in a single one of these industries—the utilisation of coal tar for the production of drugs, perfumes, and colouring-matters of every conceivable shade. The firm of Friedrich Bayer and Co. employed in 1875, 119 workmen. The number has more than doubled itself every five years, and in May of this year that firm employed 5,000 workmen, 160 chemists, 260 engineers and mechanics, and 680 clerks. For many years past it has regularly paid 18 per cent. on the ordinary shares, which this year has risen to 20 per cent.; and, in addition, in common with other and even larger concerns in the same industry, has paid out of profits for immense extensions usually charged to capital account. There is one of these factories, the works and plant of which stand in the books at £1,500,000, while the money actually sunk in them approaches £5,000,000. In other words, the practical monopoly enjoyed by the German manufacturers enables them to exact huge profits from the rest of the world, and to establish a position which, financially as well as scientifically, is almost unassailable. I must repeat that the fundamental discoveries upon which this gigantic industry is built were made in this country, and were practically developed to a certain extent by their authors. But in spite of the abundance and cheapness of the raw material, and in spite of the evidence that it could be most remuneratively worked up, these men founded no school and had practically no successors. The colours they made were driven out of the field by newer and better colours made from their stuff by the development of their ideas, but these improved colours were made in Germany and not in England. Now what is the explanation of this extraordinary and disastrous phenomenon? I give it in a word—want of education. We had the material in abundance when other nations had comparatively little. We had the capital, and we had the brains, for we originated the whole thing. But we did not possess the diffused education, without which the ideas of men of genius cannot fructify beyond the limited scope of an individual. I am aware that our patent laws are sometimes held responsible. Well, they are a contributory cause; but it must be remembered that other nations with patent laws as protective as could be desired have not developed the colour industry. The patent laws have only contributed in a secondary degree, and if the patent laws have been bad, the reason for their badness is again want of education. Make them as bad as you choose, and you only prove that the men who made them, and the public whom these men try to please, were misled by theories instead of being conversant with fact and logic. But the root of the mischief is not in the patent laws or in any legislation whatever. It is in the want of education among our so-called educated classes, and secondarily among the workmen on whom these depend. It is in the abundance of men of ordinary plodding ability, thoroughly trained and methodically directed, that Germany at present has so commanding an advantage. It is the failure of our schools to turn out, and of our manufacturers to demand, men of this kind, which explains our loss of some valuable industries, and our precarious hold upon others. Let no one imagine for a moment that this deficiency can be remedied by any amount of that technical training which is now the fashionable nostrum. It is an excellent thing, no doubt, but it must rest upon a foundation of general training. Mental habits are formed for good or evil long before men go to the technical schools. We have to begin at the beginning: we have to train the population from the first to think correctly and logically, to deal at first hand with facts, and to evolve, each one for himself, the solution of a problem put before him, instead of learning by rote the solution given by somebody else. There are plenty of chemists turned out, even by our universities, who would be of no use to Bayer and Co. They are chockfull of formulæ, they can recite theories, and they know text-books by heart; but put them to solve a new problem, freshly risen in the laboratory, and you will find that their learning is all dead. It has not become a vital part of their mental equipment, and they are floored by the first emergence of the unexpected. The men who escape this mental barrenness are men who were somehow or other taught to think long before they went to the university. To my mind, the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized a dozen industries. It is that the German population has reached a point of general training and specialised equipment which it will take us two generations of hard and intelligently directed educational work to attain. It is that Germany possesses a national weapon of precision which must give her an enormous initial advantage in any and every contest depending upon disciplined and methodised intellect.

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[*] From the Presidential Address of Professor James Dewar, LL.D., F.R.S., British Association, Belfast, September 10th.

EXHIBITIONS AND EDUCATION.

The sixty-eighth annual exhibition of the Royal Cornwall Polytechnic Society was held at Falmouth at the end of August. A special feature of the exhibition was the electrical apparatus exhibited by nearly 30 electrical firms in various parts of the country. Sir William Preece, K.C.B., F.R.S., the President, opened the exhibition, and delivered his inaugural address, in which he commended the exhibition, and remarked that in the present day exhibitions were a most admirable incentive to the encouragement of education. Having been associated in some form or another with the important exhibitions of his time, he held them to be marks of epochs in history. Another point which made exhibitions so useful was that they were gigantic advertisements; yet not mere advertisements for the sake of sale or attraction, but advertisements of the skill and industry of the people. Again, exhibitions tended very much to inspire a spirit of emulation amongst different towns. In the case of the Cornwall Polytechnic Society, however, they had been so successful that he was not aware of any other Cornish or Devon town having attempted to emulate their good example. It had been objected against the great general exhibition that it told the foreigner what England was doing. That was all very true from the point of view of the monopolist and the secretive manufacturer, but it must be remembered that it was the exhibition of 1851 which opened the eyes not only of our manufacturers but of our rulers and people to the circumstance that other countries were treading on the heels of England and walking past her. And it was the exhibition of 1851 that drove our people to encourage in every shape and form the introduction of new mechanical systems to economise and facilitate manufactures. Another advantage of international exhibitions had been that they attracted attention to the great want of standardisation, not only in our system of measurement, but in the dimensions of different machines and parts of machines. The system of standardisation in this country, when looked at as a system, was perfectly ridiculous. Take, for instance, a sporting gun. Who was there that did not know what a No. 12 gun was? But how many were there who could say why it was called a 12-bore gun? One other example was furnished by Indian railways, of which there were four or five different gauges. He hoped that eventually exhibitions would lead to the general use of what was known as the metrical system. There were two points connected with the metrical system. One was the dimensions of the standards from which they measured; the other, the numerical system of calculation in relation to each other. The numerical system of calculation was called the decimal system. Strange to relate, the decimal system was that proposed and advocated by James Watt in the year 1785. Though Watt could not get the English to take up the method, he succeeded in inducing the French to do so. The introduction of the metrical system on the decimal plan was only a question of time. The English were adhering to the old method with a sort of obstinate conservatism. He further held that exhibitions certainly tended to promote, not only national rivalry, but international harmony, besides making for peace. One exhibition was always open and at the disposal of all—the great exhibition of Nature. The ever-changing clouds, the sunshine, the thunderstorm, the wind, the rain were always objects of beauty, always of study. A nasty fog on the top of Dartmoor was very uncomfortable to walk through, but with a small scientific proclivity anybody could study the formation of fogs. Turning to this land of ours, how it had been carved and engraved by Nature! The river courses, the hills, and the dales were always food for suggestion and thought. But the great exhibit of all, the one to which he should be inclined to give the gold medal—was the sea, which was never seen twice in the same mood. Around the walls of this Polytechnic Exhibition were evidences of the influence which the sea had upon local artists. It was also the greatest delight to watch that portion of Nature which was called life. Life in all forms—fish, vegetable, animal, insect, human—was always full of novelty. He concluded that exhibitions encouraged observation, which, after all, was one of the principal sources of education. It induced discrimination and demanded payment. Observation, discrimination, and judgment were undoubtedly the highest aims of education; they encouraged skill, industry, and art. Science was becoming a commercial factor of immense moment.

On Tuesday, 26th August, the Falmouth Art School was opened by Sir William Preece, President of the Royal Cornwall Polytechnic Society. The new building was erected in memory of Miss Anna Maria Fox, who was long associated with educational matters in the Duchy of Cornwall. Nearly 70 years ago she, as a girl of seventeen, was one of the main founders of the Polytechnic Society.

Sir William Preece said it gave him great pleasure to open the school, because it was built in memory of of one he remembered well. No name had been associated with the advancement of science and art in this country so much as the name of the Foxes of Falmouth. Turning to the question of education, he said that the primary object of education and schools of this kind was to develop the power of observation, which would be one of the means by which they could instil and and induce habits of thought. This promoted a true and accurate judgment, which was the end of all education. A great need to-day was the cultivation of the memory. The ultimate aim of all these schools and systems of education was to train the brain to assist the work of the hand. That was a clear definition of technical education. Science was a word which frightened many people, but, as Huxley said, it was really systematised and organised common sense. If science was knowing, art was doing. When they did anything they were exercising an art, and it was the combination of this knowing and doing which was the whole bottom of the subject of technical education in its widest sense. Sir W. Preece went on to refer to the desirability of closer connection between schools and the Universities, and to the need for the selection of proper teachers. He believed the Government, with a true and liberal progressive spirit, had now seriously undertaken the great work of organising national education as a whole, and their reward had been obstruction of the worst kind. In these days it was difficult to say which were Tories and which Radicals, and he challenged anyone to find out what his politics were. He found now in connection with the Education Bill that the topsy-turveydom was complete, for the Conservatives were the rank outside Radicals, and the progressists who were trying to force through an admirable Bill were the present Unionist party. In spite of it all, and Conservatives or Liberals, they had the art of muddling through somehow or other. All's well that ends well, and come what might, common sense came to the surface at last. In the meantime science, art, and technical schools were springing up all over the country. The advancement of true education was mostly due to voluntary effort, and they had an illustration in this school, which was destined to make its mark on the education of Cornwall. He declared the school open.

The Bishop of Ripon, in moving a vote of thanks to Sir William Preece, remarked that the end of all education was to make men and women more valuable factors in life. After all said and done one felt increasingly that the old method of cramming boys and girls was a method more honoured in the breach than the observance. They might fill a bottle so full that it could not be emptied without sputtering, and he had thought many a well-educated person, as it was called, resembled that bottle. The object of education should be to make a man liveable—one who would bring his influence to bear upon others, and be the centre from which should radiate some wholesome, genial, and inspiring influences. His lordship trusted that the school would be a nursery of great benefit to Falmouth, the county, and to the nation.

Mr. Justice Channell seconded the motion.

PROF. FORBES'S RANGE-FINDER.

The Bisley correspondent of *The Times* has communicated the following account of the practical use of Professor George Forbes's Range-Finder, respecting which the inventor read a paper before the Society of Arts, on December 18th, last year. (See *Ante*, p. 78.)

In the course of the past Bisley meeting, I spent the best part of a morning, pleasantly and profitably, in testing Professor Forbes's range-finder, and I venture to say that my ignorance of things scientific made me exactly the person best suited to make the trial. The question to be determined was whether Professor Forbes had produced an apparatus easily portable, strong, and unlikely to be injured on the march, with which an ignorant man could ascertain rifle ranges rapidly and accurately; and the short account of the result of the trial is that, after a very short time spent in listening to lucid explanations, I found myself ascertaining ranges with marvellous accuracy.

As for the manner of working, it was simplicity itself. The Professor carried the instrument, which weighs only from 2½ lb. to 3 lb. under his arm as if it had been a light fowling-piece. I carried a tripod for use as a rest, although, as the Professor explained and demonstrated, the tripod was not really necessary, and we proceeded first to a spot just behind the 200 yards firing point. The glass was levelled at the butt. With my eyes at the glass I turned the micrometer screw until the two balloons appeared to be exactly one and the tail rope of that one balloon appeared to be exactly above one of the targets. Then on the dial by the side of the micrometer screw, which had been invisible to me when I was peering through the glasses, the distance was registered to a nicety. The same process was repeated at 500 yards, at 600 yards, and at 1,000 yards, and at 1,100 yards (the longest range at Bisley) with equally satisfactory results, and Professor Forbes then demonstrated to me that it was possible and quite easy for a man to take an observation while his body was completely sheltered by a tree or a boulder. The instrument was wonderful. An ignorant man could use it with almost the precision of a theodolite and a long base, and ascertain a range with accuracy in the course of a few seconds.

Fortunately, I am able to report that the military authorities show no disposition to neglect this valuable invention. In September, 1901, photographs and a description were sent to Lord Kitchener in South Africa, and he requested that a range-finder might be sent to South Africa. Professor Forbes himself went to South Africa at his own expense. There he made some special tests for accuracy at the Royal Observatory, some of which were certified by Sir David Gill, K.C.B., his Majesty's Astronomer, Major-General Sir John Ardagh, and Lieutenant-Colonel Edmonds, R.E. Some of these are worth quoting:—

Object.	Distance in yards.	Observed by E. F.	Error.
Mowbray Church	1,859	1,830	−29
House of Refuge	3,036	3,039	+ 3
N.E. Corner Cottages	882	857	−25
Chimney Cement Works	1,432	1,422	−10
Chimney Railway Works	1,711	1,717	+ 6

The percentage of error is ridiculously small. On February 7th Professor Forbes went to Beaufort West, reported himself to General French and Major-General Stephenson, and on the 11th joined Colonel Crabbe at Rhenosterfontein. So much impressed was Colonel Crabbe, always a keen student of musketry, by the results of a trial of the range-finder against the mekometer, that he permitted Professor Forbes, dressed in khaki, to accompany his column as range-taker. Well, indeed, might Colonel Crabbe be impressed. "Distances of points varying from 970 to 3,000 yards were asked for. In each case I gave the distance before the two men using the mekometer had finished their most necessary consultation. Sometimes the ground was such that they could not stretch their 50-yard string at right angles to the line of sight. Sometimes the target could not be seen from both ends of their base. Sometimes the kopje whose distance was required had no sufficiently definite object for the two men to select for observation." Later on the same day, "when the mekometer gave 5,000 yards as the distance of a hill which I marked as 3,000 yards, I suggested to the Colonel that his instrument was out of order. Then a new man was found for the right angle, and then their distance was 3,000 yards. After that all the distances agreed quite well with my range-finder. The great errors were due to one of the observers, and they would not have been known but for the range-finder." Of course, too, it must be remembered that the use of the mekometer necessarily involves exposure of the men using it and the drawing of the enemy's fire.

In those days with Colonel Crabbe's column the professor and his range-finder clearly did yeoman service, ascertaining each evening, on arriving in camp, the distance of surrounding kopjes, with a view to the disposition of outposts. On February 20 there was a brush with the enemy, the range-finder was in request, and it was generally admitted that it had decidedly improved the shooting. Professor Forbes remained with the column, which was on trek all the time, till the 28th, when he was provided with a class whom he instructed, with ease and success, in the use of the instrument, and it is clear from the modest account which he gave me that he won golden opinions all round. Also, during a series of rough treks, the range-finder, albeit once rolled upon by a horse, was never injured in the least, although "no more care was taken of it than a rifle." There is, finally, every reason to believe that the official reports upon the instrument have been very favourable. The expense of providing three range-finders to each 100 men, on the assumption that they require renewal once in ten years in peace time (which would not be the case) and once in five years in war time, would, it is estimated, be 6s. 8d. per man in peace time and 13s. 4d. per man in war time.

TELPHERAGE.

On the 14th of May, 1884, the late Prof. Fleeming Jenkin, F.R.S., read a paper before the Society of Arts on Telpherage (see *Journal*, vol. xxxii., p. 648).

The United Telpherage Company, of New York, have issued several papers on the uses to which telpherage can be applied. The following note is taken from one on "Telpherage as applied to the handling of trunks and baggage at railway stations."

It is interesting to note that trunks and baggage are handled to day in the same way as they were in the days of stage coaches, unless the substitution of hand trucks for wheelbarrows can be considered an advance. Although the number of pieces handled has increased by the thousandfold, yet the method is the same as our forefathers used. More men have been added, and that is all.

Although the smashing of baggage has long been regarded as a necessary evil which could not be avoided, a source of trouble and expense to the railroad company and to the passengers, yet it is strange that up to the present time no satisfactory solution has been offered.

The trunks are still lifted, conveyed and "dropped" by manual labour. The cheapest and most feasible power for conveying or transporting is electricity, and in the transportation of baggage the cheapest power comes in competition with the most expensive, namely, electricity versus man.

The conditions to be considered are: First—That no floor space should be occupied and no permanent obstructions should be allowed upon the floor of the railway station, and the baggage should be taken from the car or cars, which may occupy any position on the track or in the train, such as at either end or the middle. Second—That the trunks should be taken directly from the door of the baggage car, with no intermediate handling. Third—That the baggage should not be unloaded upon the floor, but upon carriers. Fourth—That the capacity can be increased without remodelling the plant; that is, merely by the addition of units. Fifth—Absolute freedom from danger to passengers. Sixth—Baggage to be delivered from an elevation to chutes, and to be used for incoming and outgoing baggage. Seventh—Delivery to be made at either end or side of the railway station. Eighth—Speed in transporting, to prevent any congestion; the baggage to be removed as fast as it can be discharged from the doors, utilising present trucks, with slight modifications. Ninth—That the baggage can be discharged from all the unloading doors of one or more cars simultaneously. Tenth—To produce results so that more trains per day could be operated upon a number of tracks, by preventing the delay due to the removing of the baggage. Eleventh—Free ingress and egress for passengers.

Method of Operation.—Awaiting the arrival of the train there are a number of trucks, either as single units or connected in trains. Each train consists o a Telpher and a number of trailers, each trailer supporting its own truck. Sometimes it is advisable, instead of using trailers, to use one very long truck. The advantage of trailers is that smaller trucks are more easily handled, especially when disconnected from the Telpher, and likewise the truck passes around the curves more readily. As soon as the trucks are filled with baggage, the same is elevated to any required height, and passes either forward, or back, to the right or left, when the load of luggage, or the individual pieces may be deposited wherever desired, either in the baggage room or upon an elevated platform. An electric hoist is used in connection with each Telpher, so that both the elevating and conveying are done by the same power, electricity. Any reasonable speed can be attained. The maximum amount of power required for conveying 1,000 pounds, including all losses, is less than one horse-power, and two or three horse-power for the elevating. The amount of power, therefore, used is very small. The track is made of solid steel rail, or cable of large diameter, suspended overhead. Should there be posts, it may be attached to these.

MOTORS WORKING WITH ALCOHOL.

Some of the motors shown at the Industrial Alcohol Exhibition, lately held in Paris, utilised the sophisticated spirit uncarburised; but far the larger portion employed alcohol carburised with 50 per cent. of coal-tar benzine, while some of them used one or other description at will. There were no entries in the section of two-horse stationary engines weighing no more than 30 kilogrammes (66 lb.) per horse-power; and no prizes were awarded in the special section of motors working with a mixture of alcohol and acetylene.

A work of art was awarded by the Jury to the Maison Brouhot et Cie, of Vierzon, for the large collection of its motors entered in the various classes, such motors having originally been designed for working with petroleum and being slightly modified for utilisation with alcohol. The 1·83 horse-power engine of this company, weighing 535 kilogrammes (about 10½ cwt.), with cylinder of 100 millimetres (4 in.) diameter, and 200 millimetres (8 in.) stroke, consumes 551 grammes (19½ oz.) of carburised alcohol per horse-power per hour when running with full load and making 282 to 305 revolutions per minute. A similar award fell to the lot of the Compagnie Duplex for the motor weighing 450 kilogrammes (9 cwt.), and consuming 788 grammes (27¾ oz.) of uncarburised spirit per hour when working with full load and making about 250 revolutions per minute.

In the second category, of 2 to 6 horse-power stationary engines, a gold medal was secured by the Société Anonyme l'Aster for its 6·14 horse-power motor weighing 90 kilogrammes (under 2 cwt.), and consuming 387 grammes (13 oz.) of carburised alcohol per horse-power per hour; and another by the Société Suisse de Winterthur for its 5·15 horse-power motor weighing 1,200 kilogrammes (24 cwt.), and consuming 479 grammes (not quite 17 oz.) of pure spirit per hour when working with full load.

In the third category, of 6 to 10 horse-power stationary engines, the gold medal for motors weighing no more than 30 kilogrammes (66 lb.) per horse-power was not awarded; but that for motors above this weight was awarded to M. Pruvost for his 8·35 horse-power motor weighing 1,400 kilogrammes (28 cwt.), with cylinder of 18 centimetres (7 in.) diameter and double that stroke, consuming with full load 337 grammes (not quite 12 oz.) of carburised or 440 grammes (15½ oz.) of uncarburised spirit per horse-power per hour.

Nor was the gold medal awarded in the category of 10 horse-power and upwards stationary engines weighing only 30 kilogrammes (66 lb.) per horse-power; but that for motors of greater weight was secured by MM. Brouhot et Cie with their 16·34 horse-power engine weighing 2,615 kilogrammes (2½ tons), with cylinder of 24 centimetres (9 in.) diameter and 40 centimetres (15 in.) stroke, showing naturally a lower consumption than the smaller Pruvost motor.

There were no entries of portable engines weighing no more than 30 kilogrammes (66 lb.) per horse-power; but among those of greater weight a gold medal was awarded to the 6·39 horse-power engine of M. Eugène Beaupré, weighing 700 kilogrammes (14 cwt.) for the motor alone, but 1,750 kilogrammes (1¾ ton) for the whole arrangement, and consuming 709 grammes (25 oz.) of uncarburised, or 459 grammes (16 oz.) of carburised spirit per horse-power per hour with full load.

Several prizes were awarded for motors driving pumps, dynamos, threshing machines, &c., mounted on the same bed-plate, gold medals falling to the lot of M. L. Bardon, for his 15·42 hectowatt electro-generating group, and to M. Beaupré, for his 5-horse engine driving a threshing machine, silver-gilt and silver medals respectively having been granted to the Duplex and Winterthur Companies for their engines driving pumps.

Besides the automotive vehicles of various classes, entered in the competitions for speed and low consumption of spirit (already referred to in the article, "Trials of Alcohol Motors," see *ante*, p. 665), two boats working with sophisticated alcohol were exhibited and also subjected to trials, both of them by the Société Anonyme des Anciens Etablissements Panhard et Levassor and M. Tellier, while both received a gold medal. The Centaure, with 8-horse motor, 8 metres (26 feet) long between perpendiculars, and 1·6 metre (5 feet) beam, attained a speed of 11·463 kilometres (7 miles 215 yards) per hour, with carburised spirit consumption of 5·927 cubic centimetres (0·35 cubic inch) per hour, or 0·517 cubic centimetres per kilometre (0 048 cubic inch per mile). The Lutèce, with 60-horse motor, 15 metres (49 feet) long between perpendiculars, and 1·5 metres (nearly 5 feet) beam, attained a mean speed of 28·349 kilometres (17¾ miles) per hour with a consumption of 32·33 cubic centimetres (1·97 cubic inch) per hour, or 1·14 cubic centimetres per kilometre (0·112 cubic inch) per mile.

A novel and original exhibit was an 8-horse agricultural engine, shown in action by the Société des

Tracteurs Agricoles Automobiles, of Paris, drawing after it a plough or cultivator. The 2-cylinder vertical motor, with regulator and water circulation, consumes only half a litre, or less than a pint, of alcohol per horse-power per hour while hauling, ploughing, or cultivating. The wheels are fitted with plain tires for travelling along the road; but for ploughing, harrowing, &c., or moving over ploughed land, grips are added to the tires of the hind wheels, for affording a good hold in the soil; and the change from plain to grip wheels is the work of a few minutes. Narrow flanges are also added to the front wheels for giving them lateral purchase in order to facilitate turning; and the engine can turn in almost its own length. The speed of travelling is about 15 kilometres (9 miles) per hour, and that while ploughing, cultivating, &c., about 3,000 yards per hour, while the engine can draw after it a load of from 2 to 3 tons on the level. This traction engine therefore, while working with alcohol, cultivates the ground for a fresh crop of mangold wurtzel, potatoes, Jerusalem artichokes, or other vegetables, for the production of a further supply of the industrial spirit, thus rendering a farm self-contained, as it were, and independent of extraneous sources for its fuel requirements.

BRITISH HONDURAS.

The following account of an expedition to the hitherto unknown lands of British Honduras is taken from the report of Mr. Thomas Fenwick, commander of the Expedition:—

British Honduras was formerly regarded as one of the most important of our colonial possessions. That was the time when it was wrested from the power and dominion of Spain, and when its mahogany and logwood brought immense sums into the coffers of the Imperial Exchequer. Each succeeding set of settlers from England or Scotland came and cut these valuable timbers, denuded the rich virgin forests, without planting a single tree for future generations, amassed their piles of gold, left the country and went home without leaving it any better than they had found it, either commercially, politically, socially or morally. The rich virgin soil is capable of growing almost every known fruit. Already banana culture is making progress, soon other produce will find its way into the markets of the world.

Our expedition, comprising seven men, including myself, sailed by the *Cario Girl* on Monday, May 5th, 1902, from Belize to Southern Stann Creek. The object of the expedition was to explore certain unknown lands and mountains marked on the maps, "Unexplored — Query inhabited, believed to be mountainous country as seen from the cayes."

Our voyage to Southern Stann Creek was without adventure. Here we hired a dorey (a native boat cut out of a tree), and we paddled up Southern Stann Creek towards the Coxcomb Mountains. These mountains are known as the enchanted mountains, and are associated with everything that is dreadful to all who would reveal their mysteries. Away we sped, paddling steadily, but we found that many obstacles were in the way, such as huge trees lying across the creek. These we cleared with the aid of our ever useful machete (a kind of big bread knife), and so our dorey passed safely.

The expedition was now well advanced in Southern Stann Creek which is a typical tropical waterway. On each side were huge forest trees overgrown by flowering climbers and other luxuriant vegetation, wild flowers, and many plants and orchids, which, if cultivated, would bring wealth to the firms who have the energy and enterprise to introduce them as they produce the choicest scented flowers of loveliest tints and beauty.

After all barriers to navigation were removed, we found that the dorey could pass clearly, but to our surprise, a little further ahead, an immense tree of large girth lay across the stream, but by minute measurement it was found that the dorey could be so depressed as to clear the barrier.

After dangers too terrible to contemplate at the time, we are at the Cockscomb Mountains of which so little is known and so few have come within sight of. We rested but a very short time then began our ascent. Each man armed, and carrying his pack upwards and yet upwards, those steep, solid mountain sides we climbed, butting our way step by step, now straight, now winding, now zigzag, anyway to make headway.

Having thoroughly explored the Cockscomb country, where we found no trace of human beings, we proceeded to fall back to strike in a westerly direction, with a point to the south. We travelled over extensive pine-ridges, and after many days' hard toil and exhaustion, during which water was a scarce commodity and greatly needed to quench the intense thirst from the burning sun, we at last reached the extreme limit of the track traversed by the explorer, the late Mr. Fowler, the Colonial Secretary of British Honduras. So we had there exceeded any other explorer's attainments.

Proceeding westerly we came to the range of mountains which we discovered to be quite a distinct range from the Cockscombs. These have fertile surroundings, and are capable of growing many articles now imported.

I had the honour and great pleasure of planting the Union Jack and proclaiming the land from the Cockscombs in a straight line across the map, thence to that portion marked Phillips's land and extending to the Guatemalan boundary, thence to the Toledo district to be now and henceforth known after his Majesty's title as King Edward's Land.

The effect of this will be that about 1,200 square miles of valuable land which for 200 years has been marked on our maps as "unexplored lands: Query inhabited," has been fully explored and laid open for a plan of immigration, which will increase the wealth of the colony and get out those vast stores of timber and valuable woods and minerals which await the brain of mankind.

Proceeding south-west by south we came across an extensive range of mountains. Hitherto these have been regarded as only having the appearance of mountains or mist. The mountains are of very considerable altitude and run in a westerly and southerly direction, the western slope extending into Guatemala and the southerly range runs in the direction of Sarstoon. Several of these mountains are extinct volcanoes. We hoisted the English flag, and named the important range which we had discovered after the name of her Majesty, Queen Alexandra's Mountains. The smaller range before mentioned we named the Prince of Wales's Range.

The colony is a perfect paradise where men with small capital can be independent, living on their own land and enjoying comforts which the same amount of capital in England would not allow them to live upon. This statement must be qualified by certain questions which I would like to put to the intending immigrant. The soil is so rich that almost anything will grow and the colony has a future if the intelligence of its rulers be used for progress.

Within three days from the end of our journey and being only ten miles from Seven Hills, near Punta Gorda, our supplies of provisions for four or five days before had failed and my sole support was water whilst the men ate monkey nuts which, however, I could not touch. Nature gave way and I was quite prostrate. My men urged their way to Seven Hills, and after missing their way a relief party came out from Mr. Rowland Ormsby's, a son of the Bishop of Honduras.

NATURAL GAS IN SUSSEX.

Some six years ago the need was felt of an improved supply of water at the little station of Heathfield, 46 miles from London, on the hilly and sinuous branch of the London, Brighton, and South Coast Railway that connects Tunbridge Wells and Eastbourne, and accordingly the railway company determined to see whether they could not find an underground supply, to supplement, or take the place of, the surface-water upon which they were then relying. To that end, they began to sink a 6 in. bore-hole just at the north-east end of the down platform, from the bottom of a sump 73 feet deep, which was used for the collection of the surface-water; but, although boring was continued to a depth of 377 feet below the level of the permanent way, no considerable amount of water was met with, and finally the attempt was abandoned. In the course of the operations, a smell of gas was noticed, but was disregarded, as being merely due to "foul-air" in the bore-tube, until, at a depth of 312 feet, the presence of gas made itself so strongly felt that someone applied a light to the top of the tube, with the result that there was a huge burst of flame, which was extinguished with considerable difficulty. After this, the greater part of the wrought-iron tubes lining the bore-hole were withdrawn, bnt one length was left below the bottom of the sump, and was carried up to the surface-level. In this a considerable pressure of gas (about 140 lb. to the square inch) was found to exist, and has continued to exist up to the present time, although it may fairly be supposed that, in the absence of lining-tubes, the lower part of the bore-hole fell in long ago. The railway company took advantage of this gas to light the station, employing fish-tail burners, since incandescent mantles were blown to pieces owing to the pressure, but beyond this nothing was done. People used to come to look at the lighting arrangements as a curiosity, and doubtless those that took the trouble to ask were informed that in 1895, the workmen sinking a well at the hotel, a hundred yards or so from the station, found gas, which was lighted and formed a big flame, at a depth of 228 feet. Even more than a quarter of a century ago a light lowered into a bore-hole that had been sunk at Netherfield for the purposes of the Subwealden Exploration caused an explosion, and thus gave evidence of inflammable gas. But no one seems to have paid any attention to these facts, or to have thought that they might have any significance, until a year or so ago, when some American gentlemen heard of them, and, their perceptions doubtless quickened by knowledge of what natural gas is in America, began to make serious investigations.

At the present time a company, the Natural Gas-fields of England (Limited), has one bore-hole that reaches to a depth of 400 feet, and several others are being sunk. The work is being carried on night and day, and the gas itself supplies both the light and tho power required. In the deepest hole there is a pressure of 200 lb. to the square inch—more than the working pressure of most locomotives in this counrty—and it is believed that by increasing the depth of the hole a still greater pressure can be attained, since the pressure is found to rise steadily as the holes pierce deeper into the bed of porous sandstone that covers the gas-bearing strata. Still that pressure is quite sufficient for practical purposes, for it is ample to carry the gas to any of the large cities of England. The output of the deepest boring at Heathfield is something like 15,000,000 cubic feet a day, or, say, one-eighth of the total daily sale of gas in London, and it is believed that a similar amount can be obtained from any other boring of like depth, and that the borings can be indefinitely multiplied without the yield of each being sensibly affected. The sale of gas in the towns on the London, Brighton, and South Coast and South-Eastern and Chatham Railways is calculated at about 50,000,000 thousands of cubic feet a year; therefore, on the above assumption, ten bore-holes could supply the whole of this enormous consumption; and in this connection it may be mentioned that the Natural Gas Company has acquired the sole rights to lay gas mains on all the lines of those two railways.

The gas comes from the Kimmeridge clays, and the area over which these are known to extend makes it probable that the East Sussex gas-field is larger than any known to exist in America. It is suggested, though the point can perhaps not yet be regarded as proved, that these clays are saturated with petroleum in the liquid state, and that this passes into gas as soon as the pressure on it is relieved by a bore-hole. However this may be, the gas has a distinct odour of petroleum, and analysis has shown that it contains 72½ per cent. of marsh gas, 5½ per cent of higher hydrocarbons, 4 per cent. of carbon monoxide, and 18 per cent. of oxygen; but no impurities, such as carbonic acid, ammonia, or sulphuretted hydrogen. The composition of the product of different bore-holes appears to be practically the same. This proportion of marsh gas is less than is found in many American sources, but, on the other hand, the amount of higher hydrocarbons is greater, and to this fact may be attributed one advantage the English product has over the American. The latter, burnt in an argand or ordinary fish-tail burner, is practically devoid of illuminating power; the English gas, on the other hand, burnt in the same way, without previous enrichment of any kind, gives a candle-power of 12 to 14 candles—that is to say, it is not much inferior in illuminating power to the gas supplied to London by the Gas Light and Coke Company, and is all but up to the standard to which Parliament a year or two ago, allowed the South Metropolitan Gas Company to reduce its product. At the same time, it possesses a high calorific value, and therefore gives good results with incandescent mantles, a smaller volume being consumed for equal light than with ordinary coal gas. It thus seems well suited for domestic use, whether for illuminating or heating purposes, and its capabilities in this direction will soon be put to a practical test; for supply pipes have been laid to a number of houses in Heathfield, which will thus have the honour of being the first place in England to be lighted by natural gas. It is also adapted for the production of power; several gas-engines at Heathfield are now being driven by it, no preliminary scrubbing or cleaning of any kind being required, and one gas-engine of 1½-horse power, which has been substituted for a 6-horse power steam-engine to pump water for supplying the locomotives on the railway, is stated to be working with a consumption of 15 cubic feet per horse-power, or about half the quantity of ordinary London gas often required.—*The Times*.

VANILLA.

The fruit of the *Vanilla planifolia Andr.* does not give out the characteristic odour of vanilla when freshly gathered; and it is only after the subsequent preparations that this odour is gradually developed. While writing a work on this subject for planters in the French colonies M. Henri Lecomte found that this preparation which gives very variable results, is purely empirical; and he was induced to study the conditions under which vanilla is produced. The following particulars are taken from his notes on the subject communicated to the Paris Academy of Science by M. Guignard.

At the outset M. Lecomte discovered, in the various parts of the vanilla plant, the constant presence of an oxidising ferment similar to those studied by M. G. Bertrand, and which are now known by the general denomination of "oxydases," their presence being noticed in the stalks and leaves of the plant, the liquid extracted from them, the green and ripe fruit, and also the prepared vanilla from Mexico, La Réunion, the Seychelles, and the Comores.

Strangely enough, while the most esteemed vanillas of commerce contain the oxydases in considerable proportion, those of inferior quality do not contain them at all, or only to a very slight extent. The presence of manganese, which M. Bertrand regards as the vehicle of the oxygen, was noticed in all the matters at the author's disposal.

The above observations led to the belief that the oxydases contained in the fruit of the vanilla must play an important part in the preparation of the essence itself; but an apparently serious objection may be opposed to this supposition. In the method of preparation now adopted at La Réunion, the first operation to which the fruit is subjected consists in immersing it for about twenty seconds in water kept at the temperature of 80 to 85 degrees Centigrade. Now at this temperature the oxydases might be supposed to lose their characteristic property; but experiments, repeated several times, showed that the interior of the fruit, immersed in boiling water for thirty seconds, did not acquire, after such immersion, a temperature higher than 55 degrees Centigrade. Now, in practice, whole basketsful of the fruit are immersed in hot water, which does not attain boiling point, but at most 85 degrees Centigrade, while the immersion only lasts for twenty instead of thirty seconds. It may therefore be concluded that the temperature inside the fruit never attains 50 degrees Centigrade, and that under these conditions, not only is the oxydase not altered, but that on the contrary the temperature it acquires is that which is very favourable to preservation of the essential properties.

There remained to determine the nature of the substances capable of being transformed into vanilla, under the influence of the oxidising agent. Following up this investigation, Mr. Lecomte found that the juice extracted from the vanilla plant contains another ferment possessing the property of hydratizing the starch and which, acting on a solution of coniferine, promotes the formation of a substances possessing the same reactions as that the constant presence of which was noticed in the tissues of the vanilla plant.

The simultaneous presence of two distinct ferments, one hydratizing and the other oxidising, the existence of which appears intimately connected with the production of vanilline was, therefore, noticed in the vanilla plant.

In fact, having selected two similar specimens, A and B, of ripe fruit, forwarded in spirit from La Réunion, the author proceeded to prepare them by boiling. Specimen A was first raised to a temperature of 100 degrees Centigrade for ten minutes, while B was not subjected to this operation, the two specimens being otherwise prepared in the same manner and in the same space of time. Specimen A became soft, and only gave out a scarcely perceptible odour of vanilla; but B on the contrary assumed the characteristic odour of vanilla, while having become partially covered, after a few days, with small crystals, which were easily recognised as those of vanilline.

By way of conclusion, the following hypothesis may be ventured as to the formation of vanilline in the fruit during its preparation:—The hydratizing ferment may be supposed to transform the nascent coniferine into coniferylic alcohol and glucose, the presence of which latter substance is indeed constant in vanilla; and, moreover, the coniferylic alcohol is probably transformed into vanilline by the action of the oxydase.

THE INDUSTRIES OF DAMASCUS.

There are a considerable number of local industries in Damascus the principal of which is the weaving industry, on which there are some 5,000 hand looms engaged, giving employment to about 10,000 workmen. There are nine principal kinds of materials made on these looms, as follows:—(1) "Aladja," and "Turkiyeh," two varieties of the same kind of cloth, being of silk and cotton mixed; 600 looms are engaged in making the former and 400 looms on the latter. (2) "Cutni," 1,000 looms; also of silk and cotton mixed in equal proportions. (3) "Dima," 2,000 looms, all of cotton; this material is more worn than any other. (4) "Créshi," 30 looms; known in the trade as "crépon;" it is made of silk and cotton mixed and of different colours. (5) "Shal," five looms, nearly all silk; there is also a "shal" made entirely of cotton, sold by the piece. (6) "Aba," 400 looms; of wool with a small admixture of cotton. (7) "Kefiyeh," 100 looms; of silk and cotton in varying proportions; it is a kind of puggaree or head covering worn by all Bedouins and country Moslems in general and occasionally by Christians when travelling. (8) "Perdah," 500 looms; a material suitable for curtains and hangings of all sorts, of pure wool, of pure cotton, and of mixed cotton and wool. (9) "Melayeh," 20 looms; a material of which is made the long veil covering the entire female figure, and which is sometimes of pure silk, sometimes of pure cotton, and then again of mixed silk and cotton. It is interesting to note that the "melayeh" is rapidly superseding the "izar," which is a veil used for the same purpose, but which is of British manufactured calico. According to Consul Richards, there are also from fifteen to twenty Jacquard looms working in Damascus, which are mostly employed in making another kind of "shal." Other Damascus industries are—(1) The manufacture of various kinds of furniture, upholstery, all sorts of ornamental woodwork, the whole inlaid, more or less, with the so-called mother of pearl. This industry occupies a very large number of workmen. (2) Copper and brass work handsomely and artistically hammered out, chased, inlaid with silver, and engraved. (3) Inlaid wood and bone mosaic work, out of which all sorts of ornamental and fancy articles are fashioned, some of the specimens of which are highly artistic and very beautiful. (4) Rope-making, which is carried on very extensively. The hemp appears to be of a good quality, but the rope and cord are of a poor description, and only find a market in other parts of Turkey and Egypt. It is estimated that some 6,000 cantars, *i.e.*, 1,500 tons of rope and cord are made every year. (5) Starch-making, carried on in some 22 factories, each of which makes about 3 cwt. of starch per diem, *i.e.*, about 1,000 tons per annum. The starch is manufactured chiefly of "beledi" wheat, although the "Haurani" wheat, which is the best in the market, contains more gluten; but then it is dearer than the other, which, on the other hand, is heavier and contains more bran. The present price of Damascus starch is about 2d. per lb. One kilé (1⅙ bushels) of wheat will yield 10 rottols (56½ lbs.) of fresh starch, which, when dried, becomes only 6½ rottols (36½ lbs.) of dry starch. This is exported to various parts of Turkey, but never, it is understood, abroad. (6) Manufacture of glue, in which two factories are engaged, making 17 cantars (a little over 17 tons) of glue per annum. There are four qualities of glue, known as the "ashkar" (dark yellow), the "ahmar" (red), the "thalithé" (third quality), and the "aswad" (black), the prices varying from 9 pias (1s. 4d.) the rottol of 5·65 lbs., to 14 pias (1s. 11¾d.) the rottol. The glue is used in the carpentering, weaving, and painting trades, and finds a ready sale throughout Syria, Palestine, and Egypt. Another industry is connected with the cultivation of the apricot, and consists in drying, preserving (the sweetmeat is known all over the Empire as "Kamar-ed-din"), and extracting the bitter kernel from one particular species of this fruit, the "klébi." Another industry consists of the manufacture of soap, in which seven recognised factories are engaged. There is one cotton spinning factory in the city of Damascus, of which the motive power is water. Although it is a large, spacious, and apparently well-equipped establishment, and although at different times a great deal of money has been sunk in it, it is not, and never has been, a paying concern. There is also a flourishing industry, which consists in the manufacture of native saddlery and harness, much of which is very bright and attractive in appearance. There are also several dyeworks in which indigo, cochineal, and madder root are chiefly employed. Yellow berries, which were very much used some years ago, have apparently gone out of fashion, and a German aniline dye (auramine) has taken their place, although it is twelve times as dear. As a matter of fact, yellow aged yarns are now generally imported. There are also biscuit manufactories, the product of which, known locally as "baksemot," and by the Turks as "peksemet," is sent in large quantities to the Hedjaz, and is also served out to the troops when on expeditions.

AUSTRALIAN GRAZING LANDS AND GRASSES.[*]

The excellent character of Australian dairy and other food produce generally, is largely due to the rich character of the greater portion of the grazing lands, especially in the vicinity of the sea coast, where the rainfall is most frequent and copious. In New South Wales the Illawara district, famous for its cheese and butter, possesses some of the best pasturage in the Commonwealth, consisting of different kinds of herbage in varying proportions. In newly laid down pastures, says an agricultural expert, perennial rye predominates, but the reason is that a greater percentage of seeds of this grass is generally sown in mixture for permanent pasture. Cocksfoot forms a fair percentage of the permanent herbage, and appears to withstand dry weather better than rye. White clover is also abundant, more particularly in pastures which have been laid down a few years. Under ordinary conditions, it produces an abundance of seed, and when the autumn rains set in, they readily germinate. During the spring months, should rain fall at frequent intervals, the clover grows rank, and when cows eat ravenously of it, very frequently produces hoven. With this exception, the Illawarra dairymen look upon it as a valuable pasture plant. Prairie grass is conspicuous in most pastures, the rich, succulent herbage being much relished by stock. Rib-grass is plentiful, and is regarded as an excellent feed for cows, and as increasing the flow of milk in dairy cattle that eat it. Among the useless grasses, from a dairyman's point of view, is the "meadow soft grass," or "Yorkshire fog," said to have been introduced with cocksfoot seed from New Zealand. In both new and old pastures, but especially the latter, there is a considerable percentage of indigenous grasses and plants, and in dry seasons these, more particularly the couch grass, often prove the mainstay of the pastures, the native grasses being enabled to withstand the effects of drought for a longer period than are the artificially-sown grasses. In the New England district of New South Wales some of the grazing lands are among the finest known, and during the summer months are unsurpassed for the rich, succulent, and varied character of the indigenous grasses and forage plants which clothe them. One of the most common grasses is the "wild sorghum," which is highly spoken of. Not only are sheep and cattle, we are told, fond of the herbage, but it is said that the horses eat the seed heads and fatten on them. "Kangaroo grass" is plentiful, and grows to a great height when left unmolested. "Wallaby grass" is common in places, and has a high reputation as a forage plant by reason of its drought-resisting properties. The "blue grass" is also a valuable herbage plant. The herbage likewise includes the "tussack poa," "star," or "windmill grass," and "wheat grass." The "bent grasses" are common; although only annual grasses, they yield rich, succulent herbage during the early summer months, when most other grasses are in the earlier stages of growth. The "long hair plume-grass," when in flower, is a conspicuous plant on pastures. On the banks of some creeks, and in low, damp places, the "water couch grass" is plentiful. It is a quick grower, and greedily eaten by cattle. There are numerous other native grasses which afford excellent food for live stock. Among the exotic grasses the white clover is, perhaps, the most abundant, growing more freely than in colder countries. the New England pastures in spring being literally white with its flowers. In the Camden district, near Sydney, when first settled, the tall, waving "kangaroo grass" was so plentiful that when in seed the country resembled an immense wheatfield. The grasses are much the same as in the New England district. Noxious weeds and supposed poisonous plants are found on many of the Australian grazing lands, but in most cases are kept in check by stock owners. The commonest weeds are a couple of so-called dandelions, which, although not productive of ill effects in live stock, naturally tend to diminish the quantity of useful herbage by choking out the nutritious grasses. At one time the "Cape weed" threatened to become the destructive pest, but it is being kept within bounds, as are the thistles and dock plants. The rapidly increasing importance of the dairying industry has occasioned greater attention being given to the maintenance and improvement of the pasture lands generally, with the result that their feeding and fattening capabilities have become largely extended. The growth of the more useful indigenous grasses is encouraged, and where artificial sowing is necessary, the best kinds of grass seed from Europe and America alone are used. Considerable quantities of grass seed, both indigenous and exotic, are also obtained within the Commonwealth.

MILK FLOUR IN SWEDEN.

According to a recent report from Gothenburg, a physician in that city claims to have invented an apparatus by which milk can be brought into the form of powder, like flour in appearance, but possessing all the qualities of milk in concentrated form, moisture excepted. It is said that this milk flour is completely soluble in water, and can be used for all purposes for which common milk is employed. The milk flour does not get sour, does not ferment, and in the dry state is not sensitive to changes in the weather. It can be kept and carried in tin cans, barrels, bags, &c. The cost of production is estimated by the discoverer at about 1s. 1d. per 106 quarts, and at a recent meeting of the Academy of Agriculture, samples of this milk flour were exhibited and received favourable comments. It is considered that the invention will be of the greatest importance for the utilisation of skimmed milk which heretofore has been largely wasted, but in the dry form can be transported all over the country without losing any of its original good qualities.

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[*] Communicated by Mr. John Plummer, of Sydney, Australis.

Obituary.

Sir Frederick A. Abel, Bart., G.C.V.O., K.C.B., D.Sc., D.C.L., F.R.S.—The Society has to deplore the loss of one of its most distinguished and most valuable members in the person of Sir Frederick Abel, who died at his residenee in Whitehall Court on Saturday, the 6th inst., aged 76 years. Sir Frederick Abel became a member of the Society as far back as 1856. In 1868 he was elected a member of the Council, and has since served continuously as Vice-President or Ordinary Member with only such intervals as the by-laws render necessary. He went off the Council in 1901, but was again elected a Vice-President at the Annual Meeting in July last. In 1883 he was elected Chairman, and he held the office for the usual period of two years. His first recorded appearance at any of the Society's meetings was in 1863, when he took part in the discussion on Dr. Voelcker's paper on the Injurious Effect of Smoke. From that time until his death he was a very active member of the Society, served on various Committees, frequently attended the meetings, and on many occasions presided. In the year 1891 the Albert Medal of the Society was awarded to him "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures by the application of Chemical Science, and especially by his researches in the manufacture of iron and steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

When the Imperial Institute was founded in 1886 Sir Frederick Abel was nominated by the Council representative of the Society of Arts on the Governing Body, and soon after this he was appointed Organising Secretary of the Institute, which office was at first a paid one, but later on Sir Frederick resigned the remuneration attached to it and became Honorary Secretary and Director. This office he retained until his death.

Sir Frederick Abel was of German extraction, though his father, Mr. J. L. Abel, was settled in England, and Sir Frederick's whole life was passed in this country. He was one of the first students of the Royal College of Chemistry under Hofmann, and after serving as one of Hofmann's assistants he became, first, Professor of Chemistry at Woolwich, and, afterwards, Chemist to the War Office. It was in this capacity that he acquired his great reputation in connection with explosives, the subject on which he ranked as the greatest living authority. To him is due the introduction of gun-cotton as a military explosive, and he, in conjunction with Professor Dewar, invented the powder now known as cordite. His name is also associated with the two tests for petroleum, the second of which—the closed test—he devised when it was discovered that the examination for the flashing point of petroleum in an open vessel was not entirely trustworthy.

Sir Frederick Abel, who had been elected a Fellow of the Royal Society in 1860, received a Royal Medal in 1887. He was intimately associated with many institutions besides the Society of Arts, having served as President of the British Association, the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, the Institution of Electrical Engineers, and the Iron and Steel Institute.

His contributions to scientific literature were numerous and important. His first paper in the Royal Society Catalogue was in 1847, and he was a voluminous contributor to the "Philosophical Transactions," the "Philosophical Magazine," the "Transactions of the Chemical Society," the "Proceedings of the Institute of Civil Engineers," and other scientific societies' publications.

He was made a C.B. in 1877, knighted in 1883, became K.C.B. in 1891, was made a Baronet in 1893, and a G.C.V.O. in 1901. He was twice married, but leaves no heir to the baronetcy.

Correspondence:

PAPER BUILDINGS.

A certain amount of interest and importance attaches to the extract from *The Paper Maker's Monthly*, published in your issue of the 29th August, anent the erection of a paper house at Sarinowka, in Podolia. Wooden and *papier maché* buildings have long been used in Japan and the East, mainly for lightness and for resistance to the disturbing influence of earthquakes. How far they can be adapted to the requirements of Western civilization I know not. Perhaps some of your readers may know something of their construction, and how they are treated to resist fire. A wide field is open for their application in Europe, if they are shown to reach the standard of ordinary building requirements. I should be glad to hear something on the point.

Guy Wilfrid Hayler.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHY AS APPLIED TO ILLUSTRATION AND PRINTING.

By J. D. Geddes.

Lecture I.—Delivered March 3, 1902.

The object of this and the following lectures will be to explain generally, and, as far as possible demonstrate, the means and methods at present employed in the production of illustrations by photographic processes for the printing press.

It is not expected, and I do not propose to give you, close technical details or exact formulæ of the working. Those dry bones of my subject may be ascertained by those who wish it from the numerous text-books, dealing with every branch of photo-mechanical illustration, or special information may be obtained in a practical form by attending the admirable lectures given by the technological classes organised by the Polytechnic Institutions and London County Council. I shall therefore, to the best of my ability, endeavour to describe in simple language the general principles of the various processes, and by means of the lantern and of examples, demonstrate how the results are obtained.

If there happen to be any gentlemen present who are specialists, hoping and expecting to be instructed and enlightened in the particular working of one or other of the processes, I can only say that as far as these gentlemen are concerned, I humbly apologise for appearing before them, for I am about to talk to my uninitiated friends, and try to tell them what is going on in the world of Process Illustration.

The present methods generally employed in the production of printing press illustrations by photography may be epitomised as follows:—

Photo lithography.
Type Block.—Reproductions from Line Drawings.
Type Block.—Reproductions from Wash Drawings and Photographs.

Photogravure. Rembrandt Photogravure.
Collotype.
Woodbury Type.
Type Block.—Reproductions by the Three Colour Process.

There are many other photo-mechanical processes in existence, but to describe them all would occupy much more time than the limits of these lectures permit; it will therefore be necessary to deal only with the typical processes I have named. They are in one way or other allied to all known photo-mechanical methods of producing illustrations by means of the printing press; and whilst they cover the scope of my subject, such details as I can give you about them will no doubt also more than absorb the time at our disposal.

Photo-lithography is named first, because it is, I believe, one of the earliest, if not the earliest practical application of photography to modern illustration by the printing press (I am excepting Fox Talbot's photo-intaglio process for the moment).

I hope I am right in assuming that you all know generally about photographic negatives and positives, and that you are aware there are several different kinds of negatives and positives employed in the making of blocks and printing surfaces in photo-mechanical processes; those that are necessary will be described in their place. I may say now that the old (1857) collodion process of negative making still holds its own for process work against the more modern dry plates, though there are several successful process workers now using only gelatino-bromide dry plates for their productions. The first thing necessary for a photo-lithograph is a good clean sharp negative of the subject which is to be reproduced. This negative may be made of collodion or gelatine, but it is necessary that the negative should be what is termed *dense* in the parts representing the whites, and that the lines should be clear glass. Generally speaking, photo-lithography is only employed for reproductions of line subjects, such as maps, plans, and architectural drawings, though there are modifications of the process for tone work, which I will mention later.

Now I must describe to you a principle which is the foundation of nearly every photomechanical process, viz., the action of salts of chromium in combination with organic substances. If a solution of gelatine in water charged with a small per centage of bichromate of potash, is spread on paper and dried in the dark, and then exposed to light, it will be found that the gelatine surface has lost its solubility, and has acquired a new property, that is to say, it will no longer absorb water and dissolve, but will remain permanently hard, horny and insoluble. This curious light action was discovered as long ago as 1839, by Mungo Ponton, and it is to-day the basis of a whole range of beautiful processes of illustration comprising carbon printing, photo-lithography, photogravure, photo-etching, and engraving, Woodburytype, collotype, and others.

Organic substances of the nature of gelatine, gum, starch, fish glue, isinglass, dextrine, &c., are all affected in the same way when treated with any of the bichromates, and the varied use of these substances often constitute the difference between one process and another.

To return to the subject of photo-lithography, here is a sheet of gelatined paper not treated with bichromate, and it can be exposed to light indefinitely without altering its nature. This sheet has been soaked for a few minutes in a 3 per cent. solution of bichromate of potassium in water, and dried. The light seems to act in two definite ways on bichromated gelatine, 1st, by rendering it insoluble; 2nd, by causing it to lose its property of absorbing water, or swelling. This sheet of gelatine has been exposed to light under this negative for a few minutes, and if examined closely you will observe a faint brownish tinted image of the lines of the negative. Now another curious property of this oxidised gelatine is taken advantage of. I have said that it refuses to take up water, conversely, if it refuses water, it will admit of being greased or inked, and if a roller, charged with printing ink, is passed over the surface of the gelatinized paper whilst it is in a dry state, the ink will "take" all over the paper, but immediately the sheet is dipped in water the ink is loosed or repelled from the soluble portions, and adheres only to the parts where the light has acted and rendered the gelatine insoluble. The sheet now shown indicates the effect of the treatment described, the lines represented by the clear portions of the negative, through which the light has penetrated, retain the ink, whilst the dark or shaded portions of the negative are soluble, and refuse to retain any of the ink, at once giving a positive reproduction in *ink* of the lines of the drawing.

The inked-up photographic print of the lines of the drawing now shewn to you is technically known by the name of a photo-lithographic transfer, because it is used for the purpose of transferring the ink on its surface to a lithographic stone or a sheet of zinc, from which base it is printed from in the ordinary lithographic printing press, and any number of copies reproduced. I think I need not describe lithographic printing further than to state that the principal substance used for this purpose of a printing surface is a porous limestone known as Solenhofen slate: the surface of this stone is polished smooth and level, and it possesses the property of greedily absorbing both greasy ink and water; if a drawing is made upon it with an ink composed of grease and lampblack dissolved in soap, the grease sinks into the stone, and each line of a design so drawn forms a permanent printing surface which, if the stone is damp, will take ink from a roller charged with printing ink and give it up again to a sheet of paper pressed in contact with the face of the stone. To prevent the ink "taking" all over the stone when using the roller, the stone is damped with water between each impression. The stone absorbs water everywhere except where the inked lines occur, which, being greased, naturally repel water, the simple principle being that a lithographic stone accepts ink and ink only where there is already ink, and water only where there is no ink. Zinc and aluminium plates are used instead of lithographic stone for printing from, and they are treated and used in precisely the same way as the stones; these metal sheets have the advantage of being lighter, cheaper, and easier to store and handle.

You will observe that we have only spoken up to the present of the reproduction of designs drawn in line, but within the last ten or twelve years considerable numbers of excellent illustrations have been produced by this process of drawings, which are in monochrome, and of photographs. The difficulty which occurs in dealing with reproduction of subjects which are represented by continuous graduated shades from black to white is, that there is no known printing surface or ink (excepting, perhaps, Woodburytype) which will distinguish any intermediate tone between black and white, in fact the printing press is only capable of rendering two shades, viz., black and white. This difficulty has, however, been practically overcome, and it is now quite possible to produce the graduated shades of a photograph for instance, though the graduations are not homogeneous, but are subdivided into granulations or grains, arranged close together for the deeper shades, and separating or becoming finer for the lighter tones, giving to the eye the effect of unbroken shades, though they are really not so. I shall have to speak of this in dealing with half-tone negatives for block printing a little later; at present photo-lithography is before us, and the problem of reproducing half-tones by that process. Many methods have been devised for breaking up the gradations into lines, stipple, or dots, and much ingenuity was exercised by the earlier experimentalists to produce the effect of half-tone in photo-lithography. The names of Dallas, Pretsch, Bolas, Waterhouse, Ives, and Husband are landmarks in its history. The idea throughout was the production of a grain or texture which would be to some extent discriminating, that is to say, form automatically groups of large, close grains in the deepest shadow, graduating into finer and finer grains until the lightest tints were reached. It was found that the addition of a hygroscopic salt, like calcium chloride, to the ordinary gelatine and bichromate coating for the lithographic transfer, had the effect of breaking up the texture of the gelatine image, and permitted of a transfer being made of monochromes or photographs. The process has been further developed by Messrs. Sprague and Co., who employ a method analogous to collotype for obtaining their transfers. The results of the process in their hands are very successful, and are largely used for commercial and artistic illustration. Photo-lithography generally is an important process, and it is employed for the rapid production of plans, maps, machine drawings, *facsimile* reproductions of manuscript, and notably in the Ordnance Survey Department at Southampton.

BLOCK REPRODUCTIONS OF LINE DRAWINGS.

The next important process in order of seniority and usefulness is the line block process on zinc, and it is curious in regard to it that the present methods of working are almos identical with those adopted by the original inventors. Another singular point is that the medium for sensitizing the metal plate which to-day gives the finest results, namely, bitumen, is the substanee which M. Nicephore Niepce discovered in 1827 as being sensitive to light, and he submitted photographed images on a plate coated with a film of bitumen, to the Royal Society of this country in the year named. The process has now been in use for the past 30 years or more, and the principle of photo-lithography just described to you largely enter into the working of the line block process.

The first requisite for the production of a good result is a suitable original: the drawing should be made with perfectly black lines throughout, it is of no consequence how thin the lines are, but they must be black; it is important too that the scale of reduction should not be too great; the best proportion is for the drawings to be made about one-third larger than the required block. The paper used for the drawing should be white and smooth in texture.

The negative for a line block is made preferably by the wet plate or collodion process, because of the facility with which these plates can be intensified, and the clearness of the lines; the negatives for this process must be reversed, so that the resulting picture may be non-reversed, which result can be obtained in two ways, first, by photographing through a prism or mirror attached to the lens, or second, by stripping the film, carrying the image off the glass, and turning it over.

The reversed negative is next printed on the metal which is to form the block in the following manner:—A piece of polished and perfectly flat zinc is cut to the proper size, and freshly polished in water until it is free from all trace of grease; it is then sensitised by either flowing over it a solution of asphalt in benzol, or, as is more generally used because of its rapidity, a solution composed of egg albumen, water, and bichromate of ammonia; an even film of this solution is floated over the metal, and is dried by gentle heat; as soon as it is dry it is sensitive to light, and is at once placed in a printing frame over the negative; a few minutes exposure to day light, magnesium, or electric light, is sufficient to oxidise the albumen where the light has obtained access to it through the lines of the negative; the plate is then covered all over with a thin coating of ink from a printer's roller charged with ink to which a little turpentine is added, and is then dropped into a flat dish containing cold water; the inky surface of the plate is then gently rubbed with a pledget of cotton wool, and the ink coating, together with the unused albumen, leave the plate together, except in the places where the light has acted through the negative and rendered it insoluble, the result being an image of the subject photographed on the metal, covered with a greasy, acid-resisting ink; in this state the plate is ready for the first stage of the etching process, that is to etch or bite away with acid all the metal surrounding the lines and render the pictures in high relief, so that it may be printed in a printing press in the same way as type. The etching of such a plate is the simplest thing possible in the abstract, but a considerable amount of skill and experience is required to carry the etching to a successful issue.

The theory is that a metal like zinc is quickly dissolved or etched by nitric or hydrochloric acid, so long as there is no grease or varnish on the metal to interfere with the dissolving action of the acid; that is so, but in the case of the plate we have to deal with a very thin protective coating, and with lines which are so narrow that they might be represented as knife ridges. There is also an element to be reckoned with in the fact that the acid not only etches downwards, but sideways. It is therefore necessary to proceed with some caution, and the first etching is performed for a few seconds only in a very weak acid, just strong enough to taste acid, after this the lines are slightly re-inked with a roller, and whilst the ink is wet, it is dusted with powdered asphalt or resin, and afterwards heated to melt the powder into the ink. The etching proper is then proceeded with, and occupies two to five hours, but it is by no means a straightforward operation. For a time, every few minutes the plate is taken out of the acid bath, and further strengthened with ink and resin, and as the etching proceeds, the piled-up ink on the lines is heated and melted, so that it runs down the sides of the lines to protect them from being undermined by the acid—when a sufficient depth is attained to make the lines high enough to ink sharp and clean in the printing press, the whole of the etching ink is removed, and the tops only of the lines carefully re-inked. A finishing etching is then given to remove the shoulder and steps on the sides of the lines caused by the various inkings and meltings. When finished, a properly etched plate should have each line firmly and cleanly cut, and be supported by a pyramidal-shaped base. The plate is now ready to be trimmed and mounted on wood type high for the printing press.

REPRODUCTIONS OF WASH DRAWINGS AND PHOTOGRAPHS.

Save as regards line blocks, until early in the '80's, it can be said that there was no process in existence by which paintings, wash drawings, or photographs could be "processed," to use a bad term, into the form of a surface printing block for the press, and the introduction then of the half-tone block marked an epoch in the history of photographic illustration which has done more to revolutionize the making of pictures than almost all the other processes put together. The origin of the process cannot be definitely claimed by any particular investigator. Its development was the result of a kind of evolution of Bullock's process of 1866. Meisenbach, of Munich, patented a half-tone process in 1882. Mr. Ives, of Philadelphia, Mr. W. B. Woodbury, and others were experimenting and publishing results in rapid succession, until within a period of a very few years the process as it now exists was practically established. I recollect very clearly the "dark ages" of the half-tone process, when all kinds of expedients were adopted to break up the gradations of a photograph into lines or dots by the interposition of a texture of silk or fine linen; also the days of wire gauze, ruled lines on paper, and other similar processes. The Americans were first in the field with an improved device for breaking up the image into dots, which was so much superior to anything invented in Europe that almost every other method was dropped in its favour. I refer to the diamond ruled screens made by Mr. Max Levy, of Philadelphia. These screens or gratings are so essential to a description of the half-tone process that I will occupy a few minutes of your time in telling you how they are made. A sheet of the finest plate glass is selected and is coated with a varnish composed of asphalt and wax. The coated glass is placed on the bed of an automatic ruling machine of extremely accurate construction and capable of ruling lines of any degree of fineness up to 500 to the inch, the cutter of the machine is diamond pointed and gauged to cut lines of any desired width. The lines are ruled diagonally at 45° across the glass, and the number to the inch varies according to the kind of work for which the screen is required, for newspaper printing the lines may be 50 or 60 to the inch, for commercial and catalogue printing 100 to 130, and for finer magazine or book illustration 150 to 200 to the inch. When the ruling of the glass is completed the ruled surface is subjected to the action of the hydrofluoric acid, which eats into or etches the lines laid bare by the diamond and forms a channel which is filled up with an opaque pigment. This enamel is baked in the lines in an oven, and then the surface is carefully polished until the lines are perfectly level and the spaces represented by clear glass are bright and transparent. Two of these ruled glasses are required for each screen, laid together with the lines crossing at right angles and cemented with Canada balsam. As may be imagined the screen gratings are somewhat expensive, a piece measuring 12 inches by 10 inches of 175 lines costs about £25, whilst large screens of 24 by 18 are charged at £100 or more. I am glad to state that we have now an English firm (Messrs. J. E. Johnson and Co.) who rule these screens excellently, indeed there is little to choose between this work and the best American, which is a comforting thing to say in these days when it is habit of the ever present pessimist to decry everything that is English and all that the Britisher does.

To produce a half-tone block from a picture, wash drawing, or photograph, this ruled grating is placed in front of the sensitive plate, but not in contact with it. The screen *distance* from the sensitive plate is a point of importance in making the negative, and the skilful operator has to determine this distance according to his experience, and to the character of the subject which is to be photographed. If it is placed too close the resulting negative will present what is known as a grid-iron appearance, if it is too far away, the dotting will be too close in the lights, and too small in the shadows. You will understand how necessary it is to keep a nice balance in this matter in the case of a picture which is built up entirely of an infinity of dots, shadows being represented by grouping of dots close together, with smallest of spaces between middle and light tones, by dots of different graduations in size, and the highest lights of pin point dots only. Everything is represented by dots, yet they are so accurately graded in relation to the light and shade of the original, that the eye does not detect them, unless examined closely, and the half-tone picture appears as a practical *fac-simile* of the original from which it was photographed.

The method of printing half-tone negatives on metal is similar in most respects to that described for line blocks on zinc, with this difference, that most half-tone blocks are now etched on copper, and the sensitising solution generally employed for this metal is a compound of fish glue, albumen, chromic acid, water, and bichromate of ammonia. The copper is carefully cleaned with Tripoli powder and washed, the sensitising solution is then flowed over it twice or three times and placed on a revolving table, where it is rapidly whirled, in order to spread the coating thinly and evenly over the whole surface; the coating is then dried by gentle heat in a yellow-lighted room, and the plate is now ready for exposure under the half-tone negative; three to ten minutes' exposure to an electric arc light completes the printing, when the plate is removed to a bath containing cold water, and soaked and washed under a spray of water until the unacted upon compound is dissolved out, an operation occupying five or six minutes. The image on the metal at this stage is almost invisible. In order to enable an examination of the film to be made, the plate is dipped into a solution of methyl violet, which dye immediately stains the film, and brings the picture into view. If all has gone well, the surface is dried either by flowing it with methylated alcohol or gentle heat. The next operation has an important effect, namely, a hardening of the delicate glue picture into a substance resembling enamel, and this gives the method its name—the enameline process. The plate is simply heated to a high temperature over the flame of a large Bunsen burner; during the progress of this "burning in" or enamelling, the image changes curiously; the blue picture gets pale, then grey, and eventually vanishes entirely; after a few seconds, as the plate gets hotter, the image appears as a faint brown, and gradually increases in strength until it fully attains a rich chestnut brown tint, when the heat must be withdrawn, and the plate is cooled off. The plate has now a picture fixed upon it, which is formed of a strong, hard, impermeable coating of enamel, and which will bear any reasonable amount of etching without further protection. The etching bath is made up of neutral perchloride of iron dissolved in water, and of a strength which registers 35° with a Baumé's hydrometer. The plate is first subjected to a general etching all over the plate sufficient to give the block a printing depth; that is, to etch away the spaces round the dots forming the picture so that the plate may be inked over with a printer's roller charged with ink, and a first proof of the photo-etched picture pulled in the press. In most plates made by this process a further and local etching must be performed. The dulling of the general effect caused by the interposition of the necessary screen grating has to be removed as far as possible, and this is done by artists who are specially trained for the work. The parts of the picture which are in shadow and are usually correctly rendered by a properly exposed negative, are covered over with varnish and the next tones are etched again, then these tones are covered up and the high lights are treated until the resulting picture, when proofed, correctly represents the original. The plates are then trimmed by engravers, bevelled to admit of being rivetted to the wood mounts, and are mounted type-high for use in the printing press.

Many efforts have been made during all the years these mechanically grained blocks have been in use to find a means of producing a printing surface which would give a pleasing result with an irregular grain like that given by collotype or photogravure, but the results so far have been disappointing; perhaps some of this disappointment may be due to the fact that the eye has been trained by years of use to look for and expect the smooth, clean results given by the mechanical ruled screen, and that any other result, though it may in a measure be more artistic, is not acceptable. I would like to mention, however, in closing this lecture, that Mr. Wheeler, of Bushey, has introduced a new screen for half-tone work. This promises much in the direction of the making of pictures which are free from mechanical effect, and are yet sufficiently delicate in texture to retain the finer details. His screens have no pigment in the graining; they are formed by a delicate etching of the surface, which leaves the plate very transparent, and the breaking up of the image to form the printing surface appears to be formed by causing the surface of the screen to act as if it were made up of an infinity of lenses. Some examples of this process will be shewn to you, and will be found extremely interesting.

Miscellaneous.

USE OF THE TELEGRAPH IN GEOGRAPHY.*

Few people appreciate the important *rôle* which is played by the telegraph in these days in the field of geography. It was not so very long ago that the first step towards regenerating a natural wilderness, or for securing access to new commercial openings or centres of uncivilised population, was held to be the construction of roads and railways. Means of physical access was the first step towards the development of a country which was regarded as unenlightened from the standpoint of European civilisation. It is so no longer, for the telegraph often threads its way through many a dreary waste of unpeopled earth, uncoiling its length for hundreds of miles in advance of any railway, or indeed of any road, which can in the ordinary sense of the term be described as a constructed road. I will give you an illustration. On the Patagonian pampas, not so very long ago, in the midst of a wide wilderness of snow, after losing our way in a blinding snowstorm, and camping on our tracks for the night, we struck the end of the telegraph line which is now being pushed across Patagonia, and which will eventually connect the Atlantic with the Pacific. We had seen no roads whatever for a great part of the distance we had traversed. Our daily procedure was the simple process of following a guide over the illimitable stretches of bush-covered uplands which reach down from the eastern foot of the Andes in gentle grades to the Atlantic shore; and when we did at last fall in with the great central line of trans-continental communication we found it to consist of the wheel-marks of certain previous waggons which had drifted along that way, a sort of road which it was exceedingly easy to lose in the fading light of a stormy winter's day. On this road there was nothing but a telegraph end and the tents of a few telegraph officials, and we were some 150 miles from our destination on the Atlantic coast. And so it happened that after weeks of absence from any means of communication with the outside world we were thus suddenly put in possession of its very latest news; and the very first message that passed from the end of that line into my hands was the message of peace with South Africa, signed an hour or two previously. I accepted that message as a happy omen for the result of our Patagonian mission. And thenceforward (thanks to the courtesy of the telegraph chief at Buenos Aires) nightly as we sat in the snow we read all that was important from the London evening papers of that self-same day. We were not starving by any means, but had we wanted a loaf of bread in that unbroken stretch of snow-covered bushland we certainly could not have got it; whilst here was information flowing in with a daily ease and regularity that I greatly missed when once again I was within reach of clubs and civilisation. The importance of telegraphs in the field of geography, however, is not confined to the transfer of news to casual travellers. It is the facility which it places in the hands of the geographer for determining his position in longitude that renders it so important a factor in the prosecution of a geographical survey. Everyone knows that the first duty of a geographer is to discover his latitude and his longitude. Hitherto the determination of the first has been a matter of no great uncertainty, but as regards the latter, one can only say that the confidence expressed by most explorers in the results of their observations has never been justified by the final verdict of a subsequent determination. It is, in truth, most difficult even for the most practised observer to obtain an absolute value in longitude on which he can rely within such limits of accuracy as are essential to the construction of a map where these values have to be employed differentially. The telegraph places in our hands the means of differential determinations within a degree of exactness that surpasses even that of the most careful determination of latitude; and the telegraph is everywhere. Supplementary to the facilities of time-signalling by telegraph is the wonderful accuracy of graduation introduced into the smaller classes of new instruments which in these days replace the cumbersome equipment of the past. With a small 6-inch theodolite fitted with a complete vertical circle time values can be determined within a fraction of a second, and latitude values to within two seconds of arc, always provided that that great bugbear of the astronomical geographer, level deflection, does not interfere with his results. But the same minute accuracy in graduation which has so improved the ordinary little instruments which you find in the hands of the professional geographer has, when combined with new methods for accurate linear measurement, also placed it in his power to carry out a fairly coherent and systematic triangulation with great rapidity and accuracy over large areas of country whenever the configuration and characteristics of that country are favourable. Usually they are favourable. Large expanses of flat desert, of undulating veldt, or of unbroken forest, are the exception, not the rule, and they must, of course, be dealt with as their special peculiarities demand; and for the normal conditions of land configuration, given that the explorer is specially careful about his base measurements and his initial data, he can certainly with modern instruments, and the facilities for check given him by the telegraph, carry on a rapid and comprehensive geographical survey, which will fulfil all the conditions required by the administrator, economist, political geographer, or military commander, within such limits of accuracy as will ensure its standing all the subsequent tests that geodesy may apply without any apparent map dislocation. And practically that is all that is wanted for a first map. I have used the word "rapidly." Few people (even scientific geographers) have really grasped the full meaning of the term as applied to surveys on geographical scales (*i.e.*, 1 : 250,000, or about four inches per mile, or less) under normal conditions. Such surveys can be completed quite as fast as an army can advance in the field, even granting that the advance is continuous. They can even to a certain extent precede that advance in face of an enemy. A single triangulator with a staff of two or three topographers in a fairly favourable country will be responsible for an outturn which may be counted by hundreds of square miles per day. The records of both American and Canadian surveys will prove that the marvellous progress made in the frontier econnaissance surveys of India is nothing abnormal or unexpected.

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* From the address of Colonel Sir T. H. Holdich, C.B., K.C.I.E., President of the Geographical Section, British Association, Belfast.

HEATING BY ALCOHOL.

The exhibition lately held in the Salle des Fêtes and Galerie des Machines, left by former Paris Exhibitions, was organised by the ex-Minister of Agriculture, with the object of promoting the industrial use of alcohol, that can be produced on the spot from a great variety of vegetable substances, so as to compete with imported petroleum; and the jury, presided over by M. Michel Lévy, Member of the Institute, awarded a great many prizes in the several classes. The exhibits were classed in three main divisions, corresponding with the applications of heating, lighting, and motive power, in the first of which the spirit, denaturalised, or sophisticated, as a protection against fraud on the Excise, is generally used uncarburised, but in a few cases carburised at will by the addition of—not petroleum products, which cannot dissolve in alcohol, but coal-tar benzine. The heating division was again subdivided into three classes, viz., appliances for heating rooms, conservatories, &c.; *réchauds*, or heaters, for temporary use; and various appliances for the laboratory and industrial purposes.

In the first of these classes a gold medal was awarded to the Société La Continentale Nouvelle, of Paris, for a stove with double circulation, off-take for the products of combustion and circulation between the burner and the receiver, supplemented by a salamander and a bath-heater, while silver medals were obtained by M. Paul Barbier and the Société La Régina, M. Prévoteaux, M. Delamotte, MM. Fouilloud et Cie., M. Bernier, MM. Daudel et Fils, M. Vallad, and M. Desvignes de Malapert, all of Paris, for their domestic stoves. The last-named exhibitor claims to be the first to have patented and made alcohol-heating appliances in France, and also that in his arrangement, without wick, smoke, or smell, accident is impossible. M. Bernier maintains that the care introduced into the manufacture of his stoves renders them very economical and easy of use, as he suppresses the wick, a source of great difficulty, while the alcohol is transformed into a rich gas, that leaves neither smoke nor smell. In the Fouilloud stoves, the alcohol is so shut in that it cannot become spilt nor ignite, while the gas generated takes up the air necessary for combustion just like ordinary gas. The Delamotte appliances also work with the gas generated from alcohol, having neither wick, pilot-flame, nor piping, water being brought to boiling point more quickly than with lighting gas, and at less expense.

The Distillerie La Couronne calls attention to the advantages possessed by this method of heating, viz., no carriage or handling of fuel and ashes, no loss of time in lighting, no attention required, easy regulation of the heat by merely turning a handle, slight space occupied, great cleanliness and absence of smell, while the stove can be moved about alight without the spirit being spilled. It is also stated that, with a consumption of 0·7 litre (one pint) of alcohol per hour, a "cheminée," or open fireplace, 65 centimetres high, 41 centimetres wide, and 31 centimetres deep (25 by 16 by 12 inches) will comfortably warm a room of 200 cubic metres (7,063 cubic feet) capacity.

In the class of alcohol heaters, gold medals were awarded to MM. Decamps et Cie. for their stoves with evaporation of the spirit and air injection, wick feeding, and heat regeneration, and also to M. Denayrouze, of driving-dress fame, whose *réchaud* is designed for simple vaporisation, and feeding by hydrostatic equilibrium on a circular wick, both of these heaters burning either carburised or uncarburised spirit. This class was remarkably well filled, no less than fifteen other medals of different values having been awarded.

The réchauds-cuisinières "Enfer" of M. Bernier, above mentioned, are fed, through perforated annular burners without wick, from raised spirit reservoirs; and it is claimed that the similar, but larger kitcheners, "Aux Tenailles d'Or," which transform the alcohol into rich gas, suffice for all ordinary cooking operations, and are absolutely inexplosible. It is stated that the new kitchener, "Le Bleuet," of M. Fouilloud (also named above), which burns alcohol carburised to 50 per cent. and affords an intense blue flame, will boil a quart of water in about five minutes. M. Charles Pigeon offers 10,000 frs. (£400) to anyone who can succeed in causing an explosion with his cooking stove, "Le Sauveur," the smallest size of which is sold for 3 fr. 50 cents. (2s. 9½d.). M. J. Daval exhibited his "Fourneau Transformable," which can either be used as a cooking stove, or a calorifier for warming rooms; and M. Y. Lagneau even showed an alcohol grill, which he states will cook a chop or steak of any reasonable thickness, in a few instants, without charring it or impairing the flavour.

Two silver-gilt medals fell to the lot of M. E. Pierre, one of them for a very compact heater, with flame adjustment, consisting of a circular spirit receiver, closed by a tight-fitting plug, an annular burner, and a cast-iron support for cooking utensils, while a lever, sliding in a slot in the base, permits of regulating the flame. A small basin is added for starting the combustion by a few drops of spirit, when the alcohol vapour, disengaged from the upper portion of the burner, will light of itself, and the appliance come into action. At the maximum intensity, about 180 grammes (6½ oz.) of spirit are burnt per hour, sufficient for boiling a quart of water in seven or eight minutes.

The réchaud of M. Desvignes de Malapert more nearly resembles the ordinary portable gas stove; but it has, of course, a receiver for the spirit, which flows from a slight height into the annular burners, while the pipe is bent in syphon form for preventing any alcohol vapour from returning to the receiver. The vaporisation tube contains a wire-gauze filter for keeping back impurities; and it is closed tightly by a rod passing through a stuffing-box, the conical portion being kept pressed on its seat by a spiral spring for preventing any escape. What distinguishes this stove from others of its class is a mushroom-shaped part for superheating the spirit and raising the temperature of the alcohol vapour generated, so that, however inferior the spirit may be, it must be transformed into a gas which, passing through a blower, will draw along with it the quantity of air necessary for perfect combustion.

In the third heating class, for miscellaneous appliances, MM. Fouilloud et Cie received a gold medal for their brasing lamps and blow-pipes, soldering irons, and heater for several soldering irons, all fed with carburised or uncarburised spirit as preferred. M. de Eiken obtained a large silver medal for his laboratory furnace fed with uncarburised alcohol under pressure, the gasification being effected by regeneration. There were several flat-iron heaters, some flat-irons heated by an internal alcohol flame fed from a small self-contained receiver, and also foot-warmers kept hot in the same manner.

ORNAMENTAL SEEDS.

Under the term of minor industries it has been proposed by Dr. Morris, in *The Agricultural News* of Barbados, to introduce new commercial plants, natives of other countries, but adapted for cultivation in the West Indies. In a recent number, in a paragraph on ornamental seeds, the writer says that "the present age is one in which there is a great demand for curios, and the increasing number of winter visitors to these colonies, should enable aged people and those who are only able to follow light sedentary occupations, to establish quite a small industry in mounting and preparing the ornamental seeds of the West Indies."

It is pointed out that there are in the islands numerous seeds of an ornamental character, and that they deserve to be more widely known. It is, indeed, somewhat surprising that many of these seeds have not come more generally into European use than they have done, for they have always figured prominently among the exhibits at the several International Exhibitions of London and Paris, but mostly as ornamental beads, simply strung on strings for use as necklaces or bracelets, or perhaps for ornamenting table mats. Many of them are specially adapted for such purposes, but there are others that might well be used in a superior class of jewellery, in connection with which the following may be noticed:—Horse-eye beans. These are the seeds of species of *Mucuna*, chiefly those of *M. urens*, and they get their common name from the fact of their appearance being similar to that of the eye of a horse, though somewhat smaller. They are the produce of climbing plants of the tropics, belonging to the order Leguminosæ, and are well known to travellers, in consequence of the pods in which the seeds are contained being thickly clothed with sharp, stinging hairs, which are readily detached by the slightest shake. A familiar illustration of the annoyance caused by these hairs penetrating the skin is to be found in the allied species, *Mucuna pruriens*, which furnish the cowhage, or cowitch, of pharmacy, at one time much used as a vermifuge. The horse-eye bean, when fully ripe, dries well, and becomes quite hard. It has a brown, pitted, or rough surface, surrounded with a smooth, darker band. Divided in half, hollowed out; hinged and mounted with a gold or silver rim, these seeds make excellent appendages for watch-chains, or variously treated with similar mountings, they would form quite attractive bracelets. Similar results might be obtained with nicker beans (*Cæsalpinia bonducella*). These are also the produce of a leguminous plant, two or three seeds being contained in each pod, which is of a chocolate-brown colour, and studied with stiff woody spines. The seeds are about the size of a large Barcelona nut, irregularly globular, very hard, with a shiny surface, mostly of a greyish-slate colour, but sometimes yellow, orange, nearly black, or even white. They are commonly used by the natives for making necklaces, bracelets, and rosaries. In India, where the plant is common, the kernel of the seeds is said to possess medicinal properties. The smaller seeds of the nicker, properly mounted and provided with a shank, might well be made into waistcoat buttons or ornamental buttons for ladies' dresses, as was at one time done in England with the soap-berry seed. These are the produce of *Sapindus saponaria*, a small tree, the fruits of which are fleshy and about the size of a cherry, containing one hard, intensely black seed. The pulpy portion of the fruit shrivels in drying and becomes horny; it contains a large proportion of saponin, which is readily extracted by soaking in water, and is thus much used by the people for washing fabrics, as a lather is very quickly produced. The hard, round seeds are used for making necklaces, bracelets, buttons, and rosaries, and it is said that many years ago buttons were made of them, and used in England, chiefly for waistcoats. The absence of any figure or colour in the seeds, being a dull uniform black, does not recommend them for general purposes, but with silver mounts they would be particularly suited for mourning use. The intensely hard seeds of the Gru Gru palms, for the name is applied to at least two distinct West Indian palms, namely *Acrocomia sclerocarpa* and *Astrocaryum vulgare* are, like the soap berries, black. They grow, however, to the size of a walnut, and the centre being occupied with soft oily seeds, they can readily be hollowed in the form of boxes, or cut into buttons of different shapes and sizes, and as they take a fine polish should find some general application.

Amongst the brighter coloured seeds which should find a use amongst jewellers may be mentioned crabs eyes, furnished by a common tropical climbing leguminous plant (*Abrus precatorius*). The seeds are abundantly produced in small pods, and are themselves quite small, of a bright scarlet colour, with a black spot. They are very uniform in size and weight, the average weight being 1·75 grains. Wherever the plant is grown these very ornamental seeds are used for necklaces, ear ornaments, and personal adornment of all kinds, as well as for rosaries, and for decorating boxes, baskets, &c. Dr. Watt says the plant with its open withered fruits exposing the scarlet seeds is twisted round leafy boughs to simulate the holly at Christmas time at English stations in India.

It may be worth while saying that the seeds in the fresh state contain a poisonous property which is dissipated by boiling. Experimenting with the seeds of *Abrus* Dr. Warden is reported to have found that half a seed rubbed down with a small quantity of water and injected into the thigh of a full grown cat produced fatal effects in twenty-four hours. A seed almost identical in appearance, namely, a bright scarlet with a black blotch but much larger in size, is that known as the Jumbi and produced by an allied leguminous plant, *Ormosia dasycarpa*. These seeds might well be used as a substitute for coral, especially for necklaces and for mounting in brooches, as might also those of the coral tree (*Erythrina*) which are of coral red without the black spot. A still brighter seed also without the black mark is that furnished in India by *Adenanthera pavonina*, a large leguminous tree of Bengal, South India, and Burma. It is generally known as the Andaman redwood tree but sometimes as red sandal wood, in consequence of its use as a dye in substitution for the true red sandal wood or red sanders wood. The seeds are nearly half an inch in diameter, somewhat lens shaped, that is convex on both sides and of the brightest shining red. In India they are often strung and made into necklaces, bracelets, and other articles of personal adornment. They are also used as weights in consequence of their uniformly weighing four grains. Their bright colour, hardness, and uniform size caused them to attract the attention, a year or two ago, of a London West-end jeweller, who contemplated using them for brooches, pins, rings, &c.

That many of the seeds here enumerated, as well as others, are capable of extended utilisation cannot be doubted. Job's tears, the seeds of *Coix lachryma-jobi*, are by no means uncommon in the windows of fancy jewellers, made up into chains or bracelets, and there is no reason why there should not be a much greater variety of vegetable curios to choose from. Even with the Job's tears, there are several varieties used in India that are still unknown in English commerce, and are only seen on native dresses, being used by certain tribes on account of their ornamental character. So long ago as the Colonial and Indian Exhibition in 1886, these seeds attracted much attention; and Dr. Watt, referring to them in his "Dictionary of the Economic Products of India," says, "They seem to stand a good chance of coming into use in Europe in the construction of artificial flowers, laces, bugle trimmings, and other such purposes for which glass beads are now used, and possibly also, in Catholic countries, for the manufacture of rosary beads. If found capable of being dyed a deep black [or even brighter colours] there might be an extensive demand for them, since they would be much more durable than glass." So far as we are aware this anticipation has not been fulfilled, so that there is still an opportunity to establish a trade with these and other seeds, as for instance the so-called velvet seeds of British Guiana, referred to in the West Indian *Agricultural News*[*], which would make a good and novel trimming for ladies' dresses.

RECENT PROGRESS IN LARGE GAS ENGINES.[†]

The last few years have seen a development in large gas engines which has but few parallels in the history of engineering enterprise. Gas engines of 1,200 and 1,500 horse-power are already working, and others of 2,000 to 4,000 horse-power are being constructed. In the Paris Exhibition of 1900 the 600 horse-power Cockerill gas engine created much surprise, but now the makers have in hand an engine of 2,500 horse power, and are quite prepared to build a 5,000 horse-power gas engine.

In this country the first gas engines above 400 horse-power were started in 1900 and ran with Mond gas, but at the present time the two leading English manufacturers have delivered or have under construction fifty-one gas engines of between 200 and 1,000 horse-power. Of these Messrs. Crossley Brothers, of Manchester, supply twenty-eight engines, having an aggregate of 8,300 horse-power, or an average of 296 horse-power per engine, and the Premier Gas Engine Company, of Nottingham, supply twenty-three engines with a total of 9,300 horse-power, giving an average of 404 horse-power per engine. These two makers collectively supply 17,600 horse-power, and of this power 12,500 horse power is for driving dynamos.

This is a striking proof of rapid progress, but we have to look abroad for the great achievements in this direction. Neglecting, throughout this paper, all engines below 200 horse-power, we find that Messrs. Körting Bros. and their licensees have made or have under construction thirty-two gas engines with a total of 44,500 horse-power, averaging 1,390 horse-power per engine. The Société Anonyme John Cockerill, of Seraing, and their licensees come next with fifty-nine engines having an aggregate of 32,950 horse-power; so that the average size of the engines built by this firm is 558 horse-power. The Gasmotoren Fabrik Deutz take the third place with fifty-one engines developing collectively 20,655 horse-power; and are followed by the Deutsche Kraftgas Gesellschaft and licensees, working under the Oechelhauser patents, with engines numbering twenty-eight and giving 16,900 horse-power.

Although America has lagged somewhat behind the Continent in adopting large gas engines, there is evidence that this state of affairs will not long remain. The Snow Steam Pump Works of Buffalo, New York, have only recently started the manufacture of gas engines, yet they have already put to successful work six gas engines of 1,000 horse-power each, and are now constructing two enormous gas-engine gas compressors of 4,000 horse-power each, the first to be running next November, and the second by January, 1903. The Westinghouse Machine and Manufacturing Company, of Pittsburgh, have made gas engines of 1,500 horse-power, and are prepared to build sizes up to 3,000 horse-power, either horizontal or vertical.

USE OF WHITE LEAD IN FRANCE.

The Minister of Commerce and Industry has submitted for signature by the President of the French Republic, the following decree regulating the use of white lead for house painting, accompanied by a report stating that the text has been approved by the Consultative Committee of Arts and Manufactures and also by the Council of State, while the last-named body has for the present declined to sanction total interdiction of the deleterious substance in question.

Art. 1.—In painting shops, white lead must only be used in the state of paste.

Art. 2.—The direct use by hand of products with white lead base is forbidden in house-painting works.

Art. 3.—The dry scraping and rubbing with pumice-stone of white lead paint are forbidden.

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[*] The London agents for the publications of the Imperial Department of Agriculture for the West Indies are Messrs. Dulau and Co., 37, Soho-square.

[†] Abstract of a paper read before Section G of the British Association at Belfast by Herbert A. Humphrey, M.I.Mech E.

Art. 4.—For wet scraping and rubbing with pumice-stone, and generally for all work of white-lead painting, the masters must provide overalls to be used exclusively for the work, and must enjoin their use on the men, having these overalls frequently washed and kept in good condition. All that is necessary to ensure cleanliness must be provided for the men at the spot where the work is carried on. The tools and appliances are to be kept in a good state of cleanliness, but without dry scraping.

Art. 5.—The masters must have the text of the present decree posted up in the localities where men are taken on and paid.

Art. 6.—The Minister of Commerce, Industry, Posts and Telegraphs is charged with the execution of the present decree, which will be inserted in the *Bulletin de Lois* and the *Journal Officiel* of the French Republic.

Notes on Books.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE.—General Index, vols. 36 to 58, 1890-1900, together with a History of the Development of the Iron and Steel Institute. Edited by Bennett H. Brough, Secretary. London: 1902. 8vo.

This is the third general Index issued by the Institute, the two former ones being for 1869-81 and 1882-89. The need of such an Index will be acknowledged by all who have occasion to use the Journal, and in the present case it is of particular value because it contains references to abstracts of all the more important papers relating to iron and steel published in English and foreign journals during the period covered by the Index, in addition to the references to the papers read before the Institute. The number of papers read between 1869 and 1900 was 581. The publication of the abstracts was commenced in 1871, and the abstracts for that year occupied 50 pages. In 1896 the amount of literature had so increased that it was found necessary to devote 500 pages of the Journal to the abstracts. In 1900 the number of these abstracts was 1,507. Prefixed to the Index is a History of the Development of the Institute and portraits of the eminent metallurgists who have filled the office of President. The Iron and Steel Institute was founded in 1869 at the suggestion of the late Mr. John Jones, of Middlesborough, and the first Continental meeting was held at Liege in 1873. The first President was the seventh Duke of Devonshire.

A HISTORY OF PONT-Y-TY-PRIDD, WITH AN INVESTIGATION OF THE STABILITY OF THE ARCH. By Walter Bulkeley Coventry, M.Inst.C.E. London: Sands and Co.

The town of Pontypridd, Glamorganshire, was originally a village named Newbridge, after William Edwards's bridge over the river Taff, completed in 1755. The name was changed about the year 1845 to Pontypridd, a contraction of Pont-y-ty-Pridd, signifying "the bridge of the earthen house," a mud hut having stood near to the site of the bridge. William Edwards was the son of a Glamorgan farmer, and a self-educated man. He began life as a fence builder, and then took to masonry, and gained the name of "the best workman in that part of the country." In 1746 he entered upon his career as a bridge builder. It having been decided to construct a bridge across the Taff, Edwards was chosen to design and carry out the work. His first bridge with three arches was commenced in 1746, and was destroyed by a flood in 1748 or 1749. He then decided to span the river with a single arch so as to allow a free passage to the floods. This bridge, which was completed in 1751, had a span of 140 feet and a rise of 35 feet. It almost immediately failed owing to the excessive weight of the spandrels. This failure was a great blow to Edwards, but he once more altered his design, and whilst retaining the same span and rise, introduced the cylindrical openings in the spandrels in order to lessen the weight on the haunches of the arch. This was completed in 1755, and for three quarters of a century it was the largest arch in this country. It was placed second by the construction of London Bridge in 1831 with an arch of 152 feet span. This was followed three years later by the Grosvenor Bridge over the Dee at Chester with a span of 200 feet.

Owing to the narrowness of the roadway in Edwards's bridge and the steepness of its inclines which could not be improved without endangering the stability of the bridge, it has been superseded by a more commodious bridge, built in 1857 a few feet lower down the river, which now serves for all heavy traffic. Mr. Coventry has added to his history a technical description of the stability of the bridge.

William Edwards built several other bridges in South Wales and the neighbouring county, and he died in 1789 at the age of 70. A copy of a scarce portrait of Edwards is prefixed to this book.

TIMBER: a Comprehensive Study of Wood in all its Aspects, Commercial and Botanical, showing the different Applications and Uses in various Trades, &c. Translated from the French of Paul Charpentier by Joseph Kennell. London: Scott, Greenwood and Co.

This book deals very fully with the properties of wood; the principal varieties of trees; the supply of timber from the different countries of the world; the principles of forestry; and the preservation and applications of timber. The author opens his preface with the weighty words of the great minister Colbert, "France will perish for want of wood," and after referring to the destruction of forests without any attempt at renewal, he points out that the celebrated potter Bernand Palisay in the 16th century, when France possessed forests, and the use of coal was unknown, sent forth a word of warning to the country. He wrote: "I am astonished at the ignorance of man, for it appears that to-day he only studies how best to destroy the beautiful forests that his predecessors guarded so sacredly. I would not object to their cutting down forests provided that they afterwards replanted portions of them, but they do not think in the least about the time to come, nor do they think of the trouble they are bringing upon their children in the future."

Mons. Charpentier concludes his warning as to the danger of delays in these words: "What we wish to prove (and that with great regret) is the indecision of men of authority to make known to the world their opinions upon this question of forests, and the capital importance of this hesitation. Everything which relates to forests feels the effects of this unhealthy state of things, and the clearing of the land, of trees, will continue until a second Colbert substitutes stern decrees for barren advice."

The author having shown the evils of neglect in respect to the treatment of forests, deals fully, in Part IV. of his book, with the influence of forests, their improvement and preservation, and the damage caused to wood by insects and other influences.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE. First Annual Issue. D. Chemistry, Part I. M. Botany, Part I. London: Harrison and Sons.

The Royal Society have commenced the publication of their great International Catalogue with these two parts. The branches of Science in the Catalogue are in number seventeen, from Mathematics to Bacteriology, and are lettered from A to R. Each part contains an Author's Catalogue and a Subject Catalogue.

BLACKIE'S ENGLISH CLASSICS—Milton, Keats, Shelley. LITTLE FRENCH CLASSICS—Stendhal, Erckmann-Chatrian, Victor Hugo, Michelet. LITTLE GERMAN CLASSICS—Schiller's Ballads. London: Blackie and Son.

These are books of a few pages, in French, German, and English, published at a small price, and containing selections from some of the chief authors in the literature of the countries, edited with notes, and intended for educational purposes.

Obituary.

J. I. TRACY.—Mr. John Ibbetson Tracy died at his residence at Walthamstow on the 7th inst. at the age of 75. He took a considerable interest in the local affairs of Walthamstow where he had resided for the last 25 years, and had been for six years a member of the School Board. Mr. Tracy was elected a member of the Society of Arts in 1855, and was a frequent attendant at the meetings.

General Notes.

SOUTHPORT PHOTOGRAPHIC EXHIBITION.—A Photographic Exhibition will be held in the Atkinson Art Gallery, Lord-street, Southport, from November 24th to December 6th, 1902. The Exhibition will be divided into six sections, viz.:—(1), Selected Pictorial Photographs; (2), Scientific Photography; (3), Lantern, Stereoscopic, and Decorative Transparencies; (4), Photo-Mechanical Processes; (5), General Professional Work; (6), Photographic Apparatus and Material. Entry forms filled up by the exhibitor, must be forwarded to F. W. Teague, Curator, Atkinson Art Gallery, Southport, not later than 31st October, 1902. Silver and bronze medals have been placed at the disposal of the Corporation by the Southport Photographic Society, to be awarded to such work in Sections 1, 2, 3, 4, and 5, as in the opinion of the judges merits such award. The Mayor will present a gold medal for the best picture in the Exhibition, irrespective of subject.

VENICE ART EXHIBITION.—An International Competition is opened by the Municipality of Venice for the best design, modelled, for a large gold medal to be awarded to the most important works shown at the Fifth International Art Exhibition of 1903. The medal must bear on the obverse an allegorical figure of Venice and her artistic glories, surrounded by the inscription: "*V.ª Esposizione Internazionale d'Arte della Città di Venezia*, 1903."—and on the reverse side the words: "*Gran Premio della Città di Venezia*," leaving a blank for the name of the successful competitor, the whole to be surrounded by an ornamental border. Every competitor must send in the models of the obverse and reverse sides of the medal executed in either wax or plaster, to have a diameter of exactly 120 mm. The competitors must send together with the models the respective photographic reproductions, measuring 40 mm. in diameter, which will be the dimensions of the medal. The Municipality of Venice has allotted a prize of 300 lire to the author of the model judged the most deserving of reproduction; and judgment will be given by a Commission composed of the Mayor of Venice, President of the Exhibition, the General Secretary, and three artists. The prize of 300 lire will be paid in two instalments, half immediately on the pronouncing of judgment by the Commission, the remaining half on the completion and approval of the medal. The models for competition must reach the office of the Secretary of the Exhibition (*Municipio di Venezia*) post-paid, not later than the 31st January, 1903. The models must be signed with a motto, which motto must also be written on a sealed envelope containing the full name and address of the competitor.

Journal of the Society of Arts,

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FRIDAY, SEPTEMBER 26, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1903.

These Examinations will commence on March 30th, 1903. The following is the Time Table :—

Monday, March 30 (7 to 10 p.m.).
Grade II. : — Arithmetic, German, Portuguese, Précis-writing, Russian, Chinese, Japanese.
Grade I. :—Arithmetic, German, and Type-writing (from 7.30 to 10 p.m.).

Tuesday, March 31 (7 to 10 p.m.).
Grade II. and Music : — Book-keeping, Italian, Spanish, Harmony.
Grade I. :—Handwriting, &c., French.

Wednesday, April 1 (7 to 10 p.m.).
Grade II. and Music :—English, French, Commercial Geography, Type - writing (from 7.30 to 10 p.m.), Rudiments of Music (7 to 9 p.m.).
Grade I. :—Book-keeping.

Thursday, April 2 (7 to 10 p.m.).
Grade II. :—Economics, Danish, Shorthand (from 7.30 to 10 p.m.).
Grade I. :—Shorthand (from 7.30 to 10 p.m.), Commercial History and Geography.

In the general Examinations (Grade II.), First, Second, and Third-class Certificates will be granted in each subject.

In the Preliminary Examinations (Grade I.), Certificates will be given in each of the subjects enumerated. These will be of one class only.

In Rudiments of Music Higher and Elementary Certificates are given. In Harmony Higher, Intermediate, and Elementary Certificates will be granted.

Certificates of proficiency will be granted in each Grade to Candidates who pass in certain specified subjects during a given period.

A Fee of 2s. 6d. will be required by the Society from each Candidate in each subject in Grade II., and in Grade I. a fee of 2s. for one subject, and 1s. for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Grade II.

Vivâ voce Examinations in French, German, and Spanish are held at any date, at any of the Society's examination centres, where the local Committee undertakes to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate, for not less than 24 candidates.

A Practical Examination in Vocal and Instrumental Music will be held in London, commencing on the 22nd of June. In this Examination special fees are required.

A Society's Bronze Medal will be awarded to the candidate obtaining the highest marks in the First Class in each subject in the General Examinations (Grade II.), and in Harmony, if certified as proficient by the Examiner. These medals will only be awarded to natural born British subjects.

In any subject for which 100 candidates present themselves a second medal will be given. When there are 500 candidates in any subject a third medal will be given. For every additional 500 candidates another medal will be given.

A Society's Bronze Medal will be awarded to any candidate who passes with distinguished merit in the Vocal or Instrumental Examination in Music.

The Clothworkers' Company offer First, Second, and Third Prizes of £5, £3, and £2 respectively in each of the following subjects :—Italian, Spanish, Portuguese.

The Council of the Society offer a First Prize of £3, and a Second Prize of £2, in each of the other subjects, viz. :—Arithmetic, English, Book-keeping, Commercial Geography, Shorthand, Type-writing, Economics, Précis-writing, French, German, Russian, Danish, Chinese, Japanese, Harmony.

The prizes will only be awarded to candidates (natural born British subjects) who have taken First-class Certificates, and are certified as proficient by the Examiner in each subject.

The Council have accepted the offer of a scholarship made by the London School of Economics and Political Science for the most successful candidate in Economics. It will entitle the scholar to a course of training in

Economics or Political Science, extending over three years, and to free admission to all the lectures, &c., arranged at the school during that period.

The Examinations are under the control of Local Committees, a list of which will be found in the Programme.

Copies of the programme for 1903, with full details, together with the questions for 1902, and reports by the Examiners, can be had, price 3d., on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

The questions for the years 1896 to 1902 inclusive can also be obtained (price 3d. each year) on application as above.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHY AS APPLIED TO ILLUSTRATION AND PRINTING.

By J. D. Geddes.

Lecture II.—Delivered March 10, 1902.

Photogravure.

Historically, photogravure or heliogravure is quite the earliest process of photomechanical printing rendered practical for the uses of illustration by the printing press, and its history is full of interest for the student and experimentalist. We are, however, not concerned specially in matters historical this evening, and I am expected to explain to you only its principles, some methods and just how the process stands to-day in its relation to modern illustration.

Photo-intaglio engraving, as its name implies, is just the opposite in effect to the photo-relief blocks which were described on Monday last. The principles of working are, however, practically the same as for type blocks, the results being obtained by the employment of a photographic image in combination with bichromated gelatine. The lines or gradation of the picture are sunk below the general surface of the metal and the inking of the picture, instead of being done by means of a roller, is effected by forcing the ink into the sunk lines with a dabber, the surface of the metal representing the subject is then wiped clean, and the impression is made by pressing a soft sized paper in contact with the plate by heavy pressure; the pressure forces the paper into the inked lines or depressions forming the picture and brings away the ink—the tones of the picture being represented by dark masses of ink in the deepest depressions and by lighter gradations in the shallower portions until the surface of the metal is reached, giving pure white.

Whilst photogravure justly stands at the head of all processes for artistic illustration, it is one which calls for more individual skill on the part of the engraver than almost any other. There is much uncertainty in the general results, and often more than one plate must be etched before a satisfactory effect is obtained, even then sometimes a good deal of help must be given to the plate by means of the burnisher, scraper and graver, operations which remove the process from the mechanical and call for higher artistic qualities than are generally essential for other processes.

The importance of the process renders it desirable that some demonstration of its working should be given so that the uninitiated may better understand its principles, and I am glad to state I shall be enabled to shew you some of the practical details this evening through the kindness of Mr. Howard Farmer, who has sent Mr. Symmonds equipped in order to render us this service. The various operations will be slower than my description, but if you will permit it, I propose to make a break in my paper at one or two intervals to tell you the essential points as the experiment progresses.

There are several methods of preparing photogravure plates, notably Fox Talbot's process, invented just about fifty years ago, and which is to-day, in practice, the principle of the most modern process; Klic's process, a modification of Fox Talbot's; Woodbury's process, which is I believe adopted by the French house of Boussod, Valadon and Co.; Waterhouse's process, in which an electrotype plate is prepared from a sand-grained gelatine relief; Dr. Albert's process, and many others, only differing in slight details from the first-named.

The operations of preparing a photogravure plate by the process founded by Fox Talbot, are as follows:—The first requisite is a transparency or positive picture on glass of the subject which it is desired to engrave; the transparency may be made by the carbon process, or by any of the dry plate processes, but if the latter is used the transparency must be reversed. This positive on glass should be as perfect as possible, free from spots or defects, and full of detail. A piece of finely polished copper is next selected, and carefully cleaned with Tripoli powder and water until the surface is free from the slightest trace of grease; after drying, the plate is ready to receive a graining of powdered asphalt or resin, so that the photographic image, when etched into the plate, will have the necessary roughness or grain to hold the ink required for printing. The powdered asphalt is placed in a box with an arrangement for creating a cloud of asphalt dust within the box, depending on the kind of grain required, whether coarse, or medium, or fine. An interval of some minutes is allowed to elapse before opening a door in the side of the graining-box and placing the plate face upwards for the dust to fall upon it. Three minutes is generally sufficient to ensure that the copper surface is evenly coated with the grains of asphalt. The plate is then taken out and placed on a plate of sheet-iron under which is a Bunsen burner, or is held over a flame of gas, to melt the powder so that it adheres firmly to the copper. As soon as it is cold the copper is ready for the next operation, namely, to have the gelatine resist carrying the picture transferred to it. The gelatine resist is prepared by printing an image from the transparency already referred to on a piece of sensitised carbon tissue, which is a surface of gelatine (backed with paper) mixed with some pigment like oxide of iron or carbon, and sensitised with bichromate of ammonia. The printing is carried out in the same way as for an ordinary carbon print, save that the resulting image is negative instead of positive. The printed carbon paper is immersed in water for a few minutes, and is then squeegeed to the grained copper surface, and developed with warm water until all the unacted upon gelatine is dissolved, leaving only the negative picture on the metal. This print forms the "resist" for the subsequent etching-in of the picture, and carries the whole of the gradations of tone of the picture. As soon as the print is dry (it can be dried either spontaneously, or, if the grain is asphalt, by the application of methylated spirit) the etching of the plate may be proceeded with, but it is an operation requiring some care and skill in order to secure perfect results. The etching solution is perchloride of iron, which should be pure and neutral; the strength of the solution is important. Generally speaking, three strengths of solution are required, the first tested by Baumé's hydrometer, should register 38 to 40 degrees, and only attack the deepest shadows of the plate. Four or five minutes etching with this solution is usually sufficient, then a solution of 35 degrees replaces the first, and the etching will be extended to the middle or half-tones for another period of four or five minutes; the third strength of solution is next taken, and the etching will attack the lighter tones up to the high lights. As soon as this is apparent, the etching is complete, and the plate is plunged in water and carefully washed, the resist and protection varnish removed, and the plate is ready for proofing in the press.

The graining of asphalt mentioned is commonly used for giving the etched surface a sufficient "bite" to hold the printing ink, but there are several other grains employed, notably, the mechanically ruled screen grain seen in half-tone blocks. This grain cannot be applied to the copper in the same way as resin or asphalt powder, but it can easily be added to the transparency used for printing the resist, or it can be printed on the carbon resist carrying the picture by giving it a short secondary exposure after the picture image has been printed. The advantage of the mechanical screen is that it gives a stronger grain to the plate and admits of larger and more rapid printing. Photogravure plates of this kind deeply etched may be printed from at the rate of 500 or more per hour in a copper-plate printing machine. The Rembrandt intaglio process, which, by the way, is a secret one, employs a grain of this nature, and from my observation it gives softer and smoother results than ordinary photogravure, though it lacks the brilliancy and strength of the latter. I cannot tell you how the process of Rembrandt's intaglio printing is carried out, but from experiments I have made in this direction I am inclined to the opinion that the plates are bent on to a cylinder of a machine similar to that used for printing wall papers, and that an ink composed of dextrine or starch with a pigment replaces the usual greasy ink, also that a scraper or knife is used for "wiping" the plate in the same way as in the old process of Docteur printing. I have some examples printed in this way which closely approach the Rembrandt.

COLLOTYPE.

I have on the syllabus of subjects to be considered this evening, the processes of Collotype and Woodburytype printing; either of them would supply abundance of interesting material for an entire paper, but the limited time at our disposal will admit of my giving you little more than an outline of their principles and working. The collotype process is worked universally, and is known by a variety of names; the Germans call it "Lichtdruck," the French "Phototypie," the Americans "Phototype," and we English have given it the titles of "Photo-print," "Heliotype," "Autotype," "Photophane," "Photo-mezzo-type," "Graphotone," &c.

The process is based on the well-known action of light on bichromatized gelatine, and is allied to photo-lithography, with this difference that in collotype the exposed image in gelatine is employed for the actual printing surface, and not only can line subjects be printed from it but copies of photographs, paintings and drawings. It renders half-tones so accurately that when prints by collotype process are made on highly glazed paper with a suitable ink there is scarcely any perceptible difference between them and ordinary silver prints; platinotype and bromide prints can also be closely imitated. The process is largely used for the production of view books, *fac-simile* copies of engravings, copies of paintings, "art study" portrait work, and for commercial illustrations. I have explained in a previous paper that when a film of bichromate mixed with gelatine is exposed to light under a negative, then washed and dried, it will when treated like a lithographic stone, absorb water where the gelatine film was protected from light by the dense portions of the negative, and will take ink and form a printing surface in the places where light has obtained access to the film through the negative. A collotype plate will not only take ink where absolutely clear glass occurs in the negative, but it will take ink in the half-tone in exact gradations corresponding to the amount of light passing through the negative. This property is most valuable, and, as a matter of fact, constitutes the process.

The preparation of collotype plates is not difficult, and the operations can be described in a few minutes. The printing plate is formed of a piece of plate-glass of about half an inch in thickness, ground on the printing side to give a better hold to the gelatine, In order that the film may withstand the heavy pressure of the printing press, it is found necessary to coat the plates first with a substance containing albumen, water-glass, and water. This solution is spread over the cleaned glass in a thin coating and dried. The sensitising solution for collotype printing is composed of Coignet's gelatine 3 ounces, albumen 1 ounce, water 25 ounces, and bichromate potash ½ an ounce. The exact proportions are not arbitrary, and different operators modify their solution as experience guides. The sensitising solution is carefully filtered through flannel, and, whilst warm, is poured over the surface of the "substratumed" glass plate in a fairly thick film; the coated plate is then placed on accurately levelled supports in a drying-chamber or box, and heat is applied to the bottom of the box, which is made of sheet iron. Considerable heat is required to dry the plates, and the grain or texture of the plate is affected by the speed of the drying; about four hours is the usual time occupied. When the plate is dry and cool it is ready for exposure under the negative; the qualities necessary in a collotype negative are that it must be reversed, and be of full printing strength. A negative that would render a full rich print by any silver printing process is the proper standard for collotype. The margins of the negative are masked with thin opaque paper or tinfoil, so as to permit of the picture being printed with a clean edge on paper with proper margins. The time required for the exposure under ordinary conditions, as regards light, is from twenty minutes to half an hour, but this is a matter which can only be fixed by experience. The image on the plate cannot be examined during exposure, and an actinometer scale is used for gauging the amount of light. After exposure, the plate is taken into a room lighted a dull or yellow light, and washed in running water for about half an hour in order that all the soluble unacted upon bichromate may be removed from the film, after which the plate is allowed to dry spontaneously, when it is ready for printing.

The printing may be performed in an ordinary Albion press used for letterpress printing, or in a lithographic press. For rapid printing, or for long runs, special steam driven presses are constructed, with cylinder pressure, on which it is possible to print two to three hundred copies per hour.

When the plate is fixed in position in the press, it is first wetted all over with a sponge and water, or with a solution of common salt, glycerine, and water, which, after being allowed to act on the gelatine for ten or fifteen minutes, is sponged off and the plate is rolled up with ink. If the printing is being done on a hand press, a coating of ink is applied first with a leather roller, which inks up the shadows and stronger parts of the picture. This inking is then followed by another with a gelatine roller, which inks up the half-tones and details of the subject. A sheet of ordinary printing paper is now placed over the inked surface, and pressure is applied. The result is a permanent ink print on paper of the negative used. If the printing is done on a steam press, the operations are, of course, more mechanical, but the finished result is practically the same. Large plates can be successfully dealt with at machine, and pictures on paper up to 40 by 30 inches can be printed.

The collotype process has had a long and successful career, and the beauty and delicacy of its results, when properly printed, are fully equal to that of any other photo-mechanical process, but, of late years, the advances made in half-tone blocks, and more especially in the machinery constructed for printing them, has to some extent covered the ground hitherto occupied by collotype illustrations alone, and though the half-tone block can never oust or replace collotype for many kinds of illustration, yet it is sufficiently a rival to restrict its expansion and scope from a commercial point of view.

Woodburytype Printing.

Amongst all the processes for obtaining printing press pictures by means of photography, I think that of the late Mr. W. B. Woodbury is the most audacious from a purely photographic aspect. He aimed at the highest ideal, and attained it. His process is the only photo-mechanical one which, in the printing press, realizes the gradations of tone without grain or texture of any kind; and Mr. Woodbury's working out of the process was so complete, that the operations of working it stand to-day precisely as he left it. The only variations since introduced do not alter the main principle of his invention, and refer more to mounting and transferring of the printed results than to the process itself. The idea of the process emanated from the carbon print, in which the picture is formed in all its gradations by various thicknesses of pigmented gelatine, the shadows, representing the greatest thickness, being in relatively high relief, and the high lights the lowest. Reasoning backwards, Mr. Woodbury conceived the idea of making an electrotype mould of a carbon picture, and using the mould so obtained as a printing surface by covering it over with warm pigmented gelatine, and by flat pressure attaching a sheet of paper to the pigment, so that when the gelatine jelly was set he could detach it from its mould and thus by repeating the operation obtain unlimited copies. This was practically the Woodburytype; but of course there were difficulties and imperfections, which the inventor quickly set to work to overcome. He found that a thick film of gelatine and bichromate, when exposed under a negative and washed, gave a very high, sharp relief; and he also found that when this relief was perfectly dry it possessed the property of being absolutely imcompressible, in other words, it was as hard as steel, and could be used as a die. The relief film of gelatine was placed on a block of smooth, hardened steel, with raised edges, upon this was laid a sheet of type metal or lead about a quarter of an inch thick, and the arrangement was then placed under a hydraulic press capable of exerting a pressure of about 40 cwt. to the square inch. The pressure forced the lead into the gelatine image with such accuracy that every shade and detail of the relief was impressed. The raised edges round the steel block prevented the metal from squeezing out, and on being detached, a mould in lead was obtained which could be used as a printing surface for thousands of copies. The seemingly delicate relief in gelatine was quite uninjured by this treatment, and would serve for any number of further pressed moulds.

The printing press for these pictures is special, but quite simple. It is formed of a cast iron base, on which is fitted a movable table to hold the mould, which is bedded down on to it with gutta percha; over the table is a hinged lid, faced with plate-glass, with a lever attachment for giving the pressure. The printing ink is a solution of gelatine in a hot state to which a pigment is added to give any desired tint or tone to the resulting print.

In printing the lead mould is first oiled to prevent the gelatine sticking, and a pool of the warm ink is poured on to the middle of the mould, over this pool is laid a sheet of paper waterproofed with shellac, and the lid of the press is brought down over the whole, and pressure applied. The pressure squeezes out over the edges of the mould all superfluous ink, and all that is left is that retained in the graduated hollows and depressions of the lead mould, the warm ink sets in a few minutes, and on opening the press the paper support is removed with its gelatine copy of the moulded picture firmly attached to it. This is the Woodburytype print, and it only requires drying and dipping in a bath of alum to render it absolutely permanent. The beauty and finish of these prints is beyond question, and the only drawback to them for some purposes is that they must in all cases be mounted before they can serve as book or other illustrations. There is no means of printing them directly on paper with a margin, though this difficulty has been surmounted in a round about way by transferring the thin gelatine pictures to prepared plate paper.

The Stannotype process is a modification of the Woodbury type, and was also invented by Mr. Woodbury. It has almost gone out of use now, and it will be sufficient if I explain that the printing is done direct from the gelatine relief by covering it over with a thin foil of tin. The foil prevents the wet gelatine ink from actual contact and destroying it. The printing is carried out in the same way as for the Woodbury type.

Miscellaneous.

THE WORLD'S TELEGRAPHS.

According to a recent monograph prepared by the United States Bureau of Statistics, the submarine telegraphs of the world number 1,750. Their aggregate length is nearly 200,000 miles; their total cost is estimated at £55,000,000, and the number of messages annually transmitted over them is more than 6,000,000. All the grand divisions of the earth are now connected by their wires, and from country to country, and island to island, the thoughts and words of mankind are instantaneously transmitted. Adding to the submarine lines the land telegraph systems by which they are connected, and through which they bring interior points of the various continents into instantaneous communication, the total length of telegraph lines of the world is 1,180,000 miles, the length of their single wires or conductors, 3,800,000 miles, and the total number of messages annually sent over them about 400,000,000, or an average of more than 1,000,000 each day. In the short half-century since the practicability of submarine telegraphy was demonstrated, the electric wires have invaded every ocean except the Pacific. Nearly a score of wires have been laid across the Atlantic, of which no less than thirteen now successfully operate between Europe and the United States, while three others span the comparatively short distance between South America and the African and South European coast lines. Throughout the Indian Ocean lines connect the far East with Europe and America *viâ* the Red Sea, the Mediterranean, the western coast of Europe, and the great trans-Atlantic lines. The Mediterranean is crossed and recrossed in its entire length and breadth by numerous cable lines, and the "Mediterranean of America," the Gulf of Mexico, and the Caribbean Sea is traversed in all directions by lines which bring its islands and colonies into speaking relations with each other and with South America, Central America, the United States, and thence with Europe, Africa, Asia—the whole world. Along the eastern coast of Asia cable lines loop from port to port, and island to island, receiving messages overland from Eastern Europe, *viâ* the Russian Siberian land lines, and forwarding them to Japan, China, Australia, New Zealand, the Straits Settlements, Hong-Kong, and the Philippines and receiving others in return. South America is skirted with cable lines along its entire border save the extreme south, where they are brought into intercommunication by land lines. Along the entire coast of Africa, cables loop from place to place and from colony to colony, stretching along the entire circumference, and penetrating the interior by land lines at various points.

Every body of water lying between the inhabited portions of the earth with the single exception of the Pacific Ocean, has been crossed and recrossed by submarine telegraph lines. Even that vast expanse of water has been invaded along its margin, submarine wires stretching along its western border from Siberia to Australia, while its eastern borders are skirted with lines which stretch along the western coasts of the two Americas. Several adventurous pioneers in Pacific telegraphy have ventured to considerable distances and depths in that great ocean, one cable line running from Australia to New Zealand, a distance of over 1,000 miles, and another extending from Australia to the French colony of New Caledonia, 800 miles seaward. A cable which is to connect Canada with Australia, across the Pacific, is now being laid at the joint expense of the United Kingdom, Canada, and the Australian Commonwealth, and has already been completed from Vancouver (British Columbia) to Fanning Island, just south of the Hawaiian Islands, and it is expected that the entire line will be completed by the end of the present year. The chief obstacle in the past to the construction of a grand trans-Pacific cable was found in the fact that mid-ocean resting-places could not be satisfactorily obtained, or arranged for, no single Government controlling a sufficient number of suitable landing places to make this seem practicable, in view of the belief that the distance through which messages could be sent, and cables controlled, was limited. With landing places at Hawaii, Wake Island, Guam, and the Philippines, however, no section of a cable stretching from the United States to Asia, and touching at these points, would have a length equal to that now in daily operation between France and the United States. The length of the French cable from Brest to Cape Cod is 3,250 miles, while the greatest distance from land to land on the proposed Pacific route would be that from San Francisco to Hawaii, 2,089 miles; that from Hawaii to Wake Island being 2,040 miles, from Wake Island to Guam 1,290 miles, from Guam to Manila 1,520 miles, and from Manila to the Asiatic coast 630 miles. While the depth of the Pacific is somewhat greater than that at which any cable has been laid, the difference between its depth and the greatest depth reached by cables in the Atlantic would be very slight, the cable recently laid from Hayti to the Windward Islands being in 18,000 feet of water. The recent survey for a cable between the Pacific Coast and Manila justifies the belief that a route can be selected in which the depth will not exceed 20,000 feet and may not exceed 18,000 feet. The recent survey made by the United States Navy Department disclosed the greatest ocean depths hitherto known, lying between Midway Island and Guam, and being 31,614 feet, or nearly six miles depth of water.

SUGAR CROPS OF BARBADOS, 1882-1902.

The detailed Report on the Sugar Cane Experiments for 1899-1901, carried on at Barbados under the direction of the Imperial Department of Agriculture, has recently been published, The Demerara *Daily Chronicle*, reviewing this report, refers to the leading place taken by Barbados in that branch of research which had its origin in the island, viz., the raising of new species of canes by germination, and adds that there can be no doubt that this important botanical discovery is destined to prove of real economic value in connection with the cane-sugar industry.

Some weeks ago, Mr. J. R. Bovell, the Agricultural Superintendent of the Sugar-cane Experiments, prepared a memorandum on the sugar and molasses crops of Barbados for the four years from 1899 to 1902 inclusive. Since then Mr. Bovell has prepared a further memorandum of the sugar and molasses crops for the past twenty-one years. The average price at which sugar sold per 100 lb. in 1882 was 3·80 dols.; in 1902, 1·06 dols. The average price at which molasses sold per gallon in 1882 was 25½ cents; in 1902, 7¾ cents. The market value of 1 ton of sugar and 100 gallons of molasses in 1882 was £24 17s. 2½d.; in 1902, £8 7s. 6½d. The cost of producing 1 ton of sugar and 100 gallons of molasses in 1882 was £14; in 1902, £12 8s. 7d. The gain per ton of sugar and 100 gallons of molasses in 1882 was £10 17s. 2½d.; the loss per ton of sugar and 100 tons of molasses in 1902 was £4 1s. 1d.

The data for the cost of production of sugar and molasses from 1882 to 1887 has been obtained from only a few estates. The cost from 1888 to 1897 is based on data from many estates situated in all the districts of the island. These amounts should include the cost of a ton of sugar and its 100 gallons of molasses, and also the value of the hogshead and puncheon.

The average price at which sugar and molasses sold from 1882 to 1896 is taken from a return prepared for the Royal West India Commission, and is the mean of the highest and lowest prices in each year. From 1897 to 1902 the prices are the mean of the bi-weekly prices at which sugar and molasses sold during each year's crop season.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN ALUMINIUM ALLOYS.[*]

The physical properties of certain light aluminium alloys have formed the subject of a communication,[†] and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere. The specimens are in the form of wire, 0·126 in. (3·2 mm.) diameter, supported on a wooden frame, and were placed on the roof on June 11, 1901. They have been tested after about 13 months' exposure, and have revealed some interesting facts. In order that the chemical analysis may be inspected it is again given in the following Table, which gives the results of the tests. It is assumed that the observed effects are principally due to pitting at the surface, but exposure might also affect the structure of these alloys :—

No. of specimen.	Analysis.						Specific resist. in 10—6 ohms before exposure on July 11, 1901.	Percentage variation of resist. as found on July 23, 1902.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.		
16	0·31	0·37	0·11	...	...	...	2·92	1·81
4	0·38	0·25	0·16	...	...	...	2·88	1·83
13	0·38	0·25	1·58	...	...	...	3·34	4·50
14	0·40	0·31	1·86	...	...	...	3·25	6·18
15	0·40	0·40	2·61	...	...	...	3·34	8·07
1	0·38	0·22	0 17	...	...	0·62	2·86	1·98
2	0·43	0·28	0·30	...	...	1·20	2·94	1·30
5	0·43	0·39	0·09	...	...	2·04	3·07	2·30
7	0·37	0·25	0·05	0·75	...	...	3·05	1·21
8	0·35	0·29	0 09	1·19	...	...	3·24	2·07
20	0·37	1·10	0·06	2·25	...	...	3·18	1·64
24	0·35	1·16	0·09	...	...	...	2·97	0·60
3	0·37	0·28	0·59	...	...	0·59	3·06	2·49
6	0·39	0·31	0·63	...	...	1·20	3·12	2·00
17	0·35	0·53	0·10	0·83	...	0·90	3·03	0·99
12	0·31	0·59	0·19	1·09	...	0·73	3·33	1·21
18	0·43	0·40	0·21	1·13	...	1·94	3·24	2·59
19	0·35	0·29	0·11	2·01	...	1·77	3 26	3·21
11	0·39	0·56	0·24	2·31	...	0·38	3·48	1 93
22	0·37	0·43	1·08	1·29	...	...	3·41	– 1·41
21	0·39	2·57	0·10	1·39	...	...	3·24	– 0·80
10	0·32	0·54	0 02	...	0·05	...	3·09	0·62
9	0·31	0·35	0·03	...	0·35	...	3·30	1·92
23	0·44	0 56	0·09	...	1·78	...	3·49	2·20

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[*] Paper read by Ernest Wilson (Professor of Electrical Engineering, King's College, London), at the meeting of the British Association, Belfast, Section G.

[†] See *Journal Institute of Electrical Engineers*, 1902, Part 154, Vol. xxxi.; also British Association Report, 1901 also *Journal of the Society of Arts*, December 13, 1901.

The position of aluminium in the electro-chemical series with respect to the other substances in the analysis is as follows:—Al, Mn, Zn, Fe, Ni, Cu, Si. We should expect to find that copper, widely separated as it is, would be effective in the production of corrosion. This is found to be the case (specimens 16, 4, 13, 14, 15), the effect increasing with the percentage of copper. Nickel is well separated from aluminium in the series, and alone (specimen 20) has considerable effect, but if alloyed with copper (specimen 22) the conductivity has slightly increased during exposure. This specimen is specially promising, as it has a breaking load of 45,900 lb., and limit of elasticity 36,600 lb. per square inch. It has, comparatively, a low percentage extension (0·146 with 16,250 lb. per square inch), a high coefficient of expansion (0·0000252), and a low temperature coefficient for electrical resistance (0·00178 per 1°C. between 0°C. and 100°C.). Again, iron in the presence of nickel (specimen 21) has slightly increased conductivity. This specimen has a comparatively high-breaking load of 42,200 lb. per square inch, and its conductivity is slightly larger than in specimen 22. Silicon is the most widely separated of all the substances in the above series, and it should be remembered that all commercial aluminium contains traces of silicon and iron. Since these alloys were supplied the purity of commercial aluminium has been greatly improved, so that further research may yield results from which more definite deductions may be made. For exposed light aluminium alloys it appears that copper alone should not be used in the alloy; the presence of equal amounts (about 1 per cent.) of nickel and copper certainly reduces conductivity to a small extent, but the gain in mechanical and corrosive properties is great.

THE CLAY-WORKING INDUSTRIES OF GREECE.

The modern pottery of Greece is principally of two kinds, viz., ordinary, cheap crockery ware, for common or general use, and fine ceramic pottery, artistically made and finished by men who have studied the art at the Polytechninum, and who model their work after the celebrated ancient pottery of Greece, imitating the shape, colours, finish, &c. Some of these clay-workers become very proficient, and make fine imitations of many of the ancient styles. In the preparation of the clay for pottery, brick, or tile, the Greeks sometimes mix it by hand, but often in a simply constructed clay mixer, turned by horse-power. The ordinary or common pottery is very cheap, and is used for all kinds of culinary and household purposes. Jars, jugs, vases, bowls, basins, pots, &c., of a reddish colour, and usually unglazed on the outside, but glazed within, are in general use, and can be bought at very low prices. In many places, but especially, says the United States Consul at Athens, on the Islan of Ægina, a cream-coloured water jug or ja is made, which is so porous that when fille with water the moisture keeps continually exuding to the outside and there evaporating, which wonderfully cools the contents, especially when th vessel stands in the air. These cheap "wate coolers" are used by everyone, rich and poor, and great numbers of them are manufactured and sold every year. These jars are very cheap, but friable Many thousand jugs of the red ware are continually in use for carrying and holding water. Pottery manufactories are very numerous in Greece. In Athens there are a dozen or more, the most noted of which are in the "Keramiekos" (clay workers quarter in the western portion of the city, and on the "Sacred Way" of the ancients. They turn out many kinds of crockery, and some very good imitations of ancient vases, &c. In the Cyclades, and in all the islands of the Ægean Sea, there are pottery manufactories, and the pottery of each island has certain characteristics peculiar to itself, owing to the difference in the clay, or the method used in its manufacture. Roofing tiles are manufactured in immense numbers in Greece. In and near the cities and large villages there is scarcely any other kind of roof in existence, but in the mountain villages some of the roofs are covered with flat stones, or slabs of stone. Tiles are manufactured in or near every city or town of any size in the kingdom, suitable clay for the purpose being plentiful and widely distributed. The tiles are made by hand, the only machinery used being a simple and primitive "mixer," turned by a horse or mule, which mixes the clay in a pit in the ground. With the exception of those situated in and near Athens, the outfit of the Grecian tile manufactories is neither elaborate or costly. A tile manufacturer of the smaller towns can often carry his entire plant on the backs of two or three donkeys, and thus move from village to village where there is a demand for tiles. Drain tiles and chimney tiles are made in considerable quantities. Nearly all the chimneys on dwellings in Greece are simply tiles built into the walls of the building, and extending to three feet above the roof. Ventilators are made in the same way. With the exception of those producing marble, of which there are many good varieties, magnesite or other minerals, the mountains of Greece are principally limestone. Very few cities or villages of the kingdom are far from a limestone quarry, and the houses are frequently built of this material, many of the best buildings being faced or ornamented with marble. Most of the houses, however, are built of stone and stuccoed on the outside—and often on the inside—and painted in good imitation of marble. This stucco lasts many years on the exterior of buildings in Greece, where frost is seldom seen, and is cheaper than marble. In some country villages, where the quarries are very far away or the roads are bad, houses are often built of sun-dried brick, but in parts of northern Greece, especially in the small villages of Thessaly, houses are built by first erecting a frame of willow poles and rods and then covering this wicker-work with a coating of mud or clay mortar. Sun-dried bricks are used in considerable quantities. The humbler houses in the suburbs of the cities of Athens, Piræus, and Patras, and in many villages where stone is not plentiful or easy of access, are built of sun-dried bricks. In fact in some villages the houses are nearly all built of this material. Many fences or walls throughout the country are composed of blocks of clay one yard square and half a yard thick, made in a manner somewhat similar to the manufacture of sun-dried bricks. The bricks, as the name implies, are dried by the heat of the sun only. They vary in colour, according to the colour of the clay used, and measure about twelve by six by two and a half inches. These bricks are made in every village, town, and farm in Greece that has clay, and there are few places in the kingdom that have no clay deposits. Kiln-dried or burned bricks are manufactured in or near Athens, Volo, Chalkis, Pyrgos, and elsewhere in Greece ; they are of a hard quality and usually of a very light cream colour. It is said that no soft kiln-burned bricks are made. Kiln-burned bricks are used for the erection of chimneys in factories, foundries, &c., partitions in buildings, bakers' ovens and furnaces, and sometimes for building drains and sewers. Iron chimneys or "smoke stacks" are seldom erected. On account of the limited use of kiln-burned bricks in Greece, the manufactories of this material are few. There are but four or five of importance, and even these do not make bricks exclusively—they also manufacture tiles. Like the sun dried, the kiln-burned bricks are made by hand, the only machinery used being the simple "mixer" propelled by horse-power. One man can mould 3,000 bricks each day. After the bricks are moulded they are allowed to be in the sun until partially dried, and stiff enough to handle easily. They are then built up in an "open work" manner, so that the heat from the fire can reach each brick. The fuel used is nearly always wood, and the fire, never very hot, is kept up for about fifteen days.

MUNICIPAL TRADING.*

The broadest objections to municipal trading would seem to be six in number :—The injurious effect upon the work strictly within the municipal sphere of operation; the fact that in giving attention to trading operations the "unproductive" work is almost certain to be neglected; the tendency to discourage improvement or development; the engendering of ill-feeling which is sure to arise when the taxpayer finds himself obliged to help defray the cost of competing with himself; the difficulty in adjusting the burden of a trading undertaking on the right shoulders, and such an equitable regulation of the charge as will not put a burden on those who derive no benefit ; the impossibility of drawing a line as to which industries shall be taken up by municipalities, and which shall be left to individual enterprise.

In the early part of the last century the various State Governments of the United States entered into financial partnership with the promoters of canals; and later, when steam railways were introduced, States and cities, and towns and counties, were alike appealed to for assistance in building railways. Nor was the appeal unheeded, for in the forties and fifties an epidemic, very similar to the present fever for municipal trading in England, literally swept over the country, and ended in bankruptcy and ruin, not only of cities and towns, but of important States. Bonds issued by State and local authorities for the promotion of railways went in default.

These and kindred experiences taught us the useful lesson that there was a limit to State and municipal credit. The taxpayers of those times, who saw their property practically confiscated to pay for enterprises which should have been left to individual endeavour or private speculators, invented a device known to us as "the debt-limit clause;" and this clause, in some form or other, has been inserted in nearly every State Constitution drawn and adopted since those days of financial disaster and destruction of State and local credit.

Partially because of the debt limitation, and partially because private enterprise has been allowed a freer headway in such undertakings as the supply of gas, electric lighting, tramways, and telephones, we find in the United States no city owning and operating its own tramways and street railways, probably less than half-a-dozen manufacturing gas, a very few engaged in supplying electric light, and, I think, not one in the telephone business.

Municipal trading is rapidly increasing municipal debt in England, and serious complaints may be heard on all sides in consequence of the increase of local taxation. The answer is that the debt is "productive," and that the profits of these industrial undertakings will be used to reduce the taxes. Sir Henry Fowler's admirable statistical classification of indebtedness shows that the so-called "productive" debt is only about half of 1 per cent. beyond the danger line ; that is, the dividend or profit from this debt averages half of 1 per cent. If, in consequence of the anxiety in financial circles at the steady increase of local debt, the rate of interest should rise $\frac{1}{2}$ per cent. on all local securities, what would become of the "productive" debt ? Assuming that the trading debt represents one-third of the total local debt, a rise of a $\frac{1}{4}$ per cent. would extinguish the "productive" properties of these loans, and, in a sense, throw them on the rates.

Without suggesting any remedy for municipal trading, an alternative plan would be the leasing system, which, when the contracts are wisely drawn, secures the revenue for the city treasury and good cheap service for the public. On the other hand, it shifts the financial risk from the ratepayers' shoulders. This, with some form of debt limitation, will gradually modify existing conditions, especially if backed by a strong public opinion in opposition to further use of public funds in this manner. In spite of the activity of municipalities in England, private capital has not been entirely beaten in the race; while I observe in certain quarters it holds its own admirably in competition with tax-exploited industry. Even the capital invested in private company electrical undertakings is increasing, and this in spite of almost insurmountable obstacles. It is a case for gradual readjustment, not violent change. With the facts fully understood, the people will by degrees curtail these unwise and dangerous economic experiments, and bring cities back to the sphere of work which is strictly their own.

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* Abstract of paper read by the Hon. Robert P. Porter (Director of the Eleventh U.S. Census), before Section F., British Association, Belfast.

NEW FOOD PLANTS IN YUCATAN.

The gardens and fields of Yucatan are filled with succulent vegetables and sweet smelling herbs unknown to the outer world. In the cultivated fields at the proper season are grown Indian corn, beans, and tubers for which we have no name, for the reason that they have been neither seen nor heard of outside Yucatan. The forests and jungles contain fruits that, excellent even in their wild state, could be made delicious by scientific care and cultivation. There are many wild fruits that offer more promising results than did the bitter wild almond, the progenitor of the peach.

The most important of the large cereals is the maize of the Mexicans, the Indian corn of the Americans, and the *ixim* of the Mayas of Yucatan. Like several other vegetable products, its origin as a cultivated plant is enveloped in obscurity, the wild plant from which it was evolved not yet having been identified. Many believe that the cultivated plant had its origin somewhere between Yucatan and the tableland of Mexico. The mother plant was probably a grass and the new grain spread to all parts, each one giving it certain characteristics until the varieties grown in the north hardly seem related to those of the southern lands. The United States Consul at Progres says that Yucatan has six varieties of this grain, and the Maya Indian reverently speaks of it as the "grace of God." The long stalked, large grained class known to the natives as *xnuc nal*, is the most prominent, and has by far the greatest acreage devoted to its cultivation in Yucatan. It is planted in May, is fully matured in January, and then is left to harden and season until gathered as needed. This class most nearly resembles the Indian corn of the United States. It has both the white and yellow grains. Under the haphazard methods of the native Indians, the corn produces in the limestone soil of Yucatan from 20 to 30 bushels to the acre. Under favourable conditions this yield is often doubled. The *xmehenal* is a small, quick growing variety, and the plants are rarely 4 feet high. The natives have a saying "that the cock can pick the flowers of the true xmehenal without stepping off the ground." One variety matures within sixty days of its planting, and the second needs fifteen days more. The *xmehenal xtup*, planted in May, can be gathered in July, and while the production per acre does not quite reach the figures of the *xnuc nal*, it has a greater capacity of resisting the extremes of heat and dryness. The plant, or rather the running vine, known as the *macal box*, produces a tuberous root of great nutritive value. Entire families have lived upon this root for weeks at a time, and were healthy and apparently well nourished. This plant is very productive. About the middle of May the green shoots first appear above the earth, they grow rapidly, and in November are ready to be dug. The tuber is about the size of a large potato, and is of a purplish colour, like a certain class of sweet potato, and it can be cooked in the same way as a sweet potato. The plant is hardy. A long drought may cause the vine to wither, but with the lightest rain it springs up anew. The roots left in the ground as too small for food propagate the plant, and each year the yield increases. It seems to be a kind of native yam; it grows in almost any kind of moderate rich soil, and when cultivated intelligently should be of some value as a food plant. The *xmakin macal*, like the *macal box*, appears in May and is gathered in November, but it yields only one or two tubers to the plant. These, however, are of large size, resembling enormous potatoes. The interior is white and seems to be nearly pure starch. The plants grow close together and the yield per acre is said to be phenomenal. *Xmehenchi-can* seems to be a kind of artichoke, weighing when mature about a pound. The plants are running vines, rarely more than a yard long. An acre will yield an immense crop under favourable conditions. The plant sown in August can be gathered in November. *Xnucchi-can* is a larger root, weighing when mature about three pounds. It is a hardy plant and produces well. Both of these roots are eaten, roasted or boiled, and many like them raw.

AGRICULTURAL IMPLEMENTS IN CHINA.

North China, Mongolia, Manchuria, and that part of Siberia bordering on the Pacific are destined soon to become consumers of agricultural implements, as the greater part of the country is susceptible of cultivation. The production of wheat is already a leading industry in various districts, but it is carried on without the use of any modern machinery. The United States Consul at Newchwang says that there are several reasons why this territory may be considered a good field for marketing agricultural implements. First, the country is not as a rule thickly populated; this is especially true of Mongolia, Manchuria, and Siberia. Labourers are imported each season to assist in planting and harvesting crops. There exists therefore more of a disposition to economise labour than is generally found in other parts of China. Second, the whole of the country is abundantly supplied with animal power. Ponies, mules, donkeys, and cattle are used in every way to relieve the burdens of man. There are few parts of the world where animal power is more generally used than in North China. Ploughs, harrows, rollers, carts, and various other crude machines, locally made, are in constant use. The hand tools and the methods in use in other parts of China for cultivating, harvesting, and marketing crops are not so extensively employed there. As the people are so well trained in the use of this animal power and already use many crude machines there will not be serious difficulty in introducing better appliances. Third, the country is generally cultivated in much larger fields than in middle and southern China, and the employment of improved machinery would involve no change in the nature of their industry. Fourth, the opening of the country by railways will reduce the cost of getting products to markets and at the same time will increase the supply. While these more general features are conducive to the introduction of agricultural machinery it must not be understood that there are no difficulties. The expansion of Russia and the advent of Russians in Siberia, Mongolia, and Manchuria will have a tendency to enlarge the use of machinery, but for an immediate market it is necessary to overcome the natural conservatism of the Chinese. Consul Miller quotes two examples, as follows:—About twenty years ago, an Englishman brought two ploughs to Newchwang. He tried to sell them, and could not; he endeavoured to give them away, but no one would take them; then he made an effort to get someone to experiment with them, but he could not even get a man to harness a team to one. A more recent experiment was the introduction from the United States of ploughs of the type used in Hindoostan. The general form of this plough, with a single upright handle, similar to the native plough, it was thought would make it acceptable, but unfortunately it had a long beam, and was designed to be attached to a yoke over the animal's neck, and so it proved a failure. Above all other considerations, the plough must be cheap, as cheap as it is possible to make it. The form must differ very little from that now in use by the native—short beam, single handle, and as simple of construction as possible, and the market if secured, would, in the opinion of the Consul, receive millions of ploughs. The vast area of splendid soil for grain production, the reliability of climatic conditions that make crop failures and famine most uncommon, the proximity of the country to the Pacific Ocean, the development of railways, and the frugal, industrious habits of the people, all promise a great increase in wheat and grain production, and make this an inviting market for agricultural machinery.

*GEOGRAPHY OF SOUTHERN PERSIA.**

Southern Persia and Baluchistán lie between the rich alluvial plains and ancient civilisations of the Euphrates, Tigris, and Kárun on the west, and that of the Indus on the east. Washed throughout to the south by the Persian Gulf and Arabian Sea, the country maintains a low level for a considerable distance inland, and the heat in summer is terrific. Additional disadvantages are the absence of good harbours, and the fact that in the Persian Gulf there is always either too much or too little wind. This coast strip runs back to range after range of rugged mountains, increasing in altitude until the Irán plateau is reached. The fertile zone of upland country is not very wide, and it soon decreases in elevation, sloping down to the paralysing waste of the Lut.

The characteristics of Baluchistán are to a considerable extent similar, except that the altitude of the mountain chains is not so great. As cultivation depends on irrigation, the absence of ranges sufficiently lofty to serve as storehouses for snow results in the encroachment of the Lut much further south. Indeed, the eastern border of the Kermán province is separated from Beluchistán by a section of this desert, some 200 miles in width, which is an important factor in the history of Southern Persia. In its east and west aspect, from the Tehrán-Isfahán-Shiráz-Bushire road eastwards the Lut stretches right across the entire width of Persia, thus separating the land of Irán into two divisions far more effectually than any sea or mountain barrier. To summarise, Southern Persia and Baluchistán have ever been comparatively barren countries, most difficult of access from the coast, and consequently have always escaped invasion by sea. Owing to the hardening influence of a livelihood gained from a sterile soil, and perhaps still more to the superb climate, a warlike race was produced, which frequently held in subjection the inhabitants of the rich low-lying plains to the west, while more than once the martial hosts of Irán have swept all before them in the plains of India.

Concerning the variable lower course of the Helmand, the author gained some interesting details when travelling in Sístán nearly four years ago. Indeed, it must be recollected that Sístán is not only fed by the Helmand, the classic Etymander, but that its waters form the lagoon in which this interesting river discharges. To summarise the courses taken by the Helmand, in the 14th century there was a solid dam, known originally as the Band-i-Rustam and later as Band-i-Akwa (evidently a corruption of Afghan or Agwan). This was situate at a point on the Helmand some forty miles east of the ruins of Hauzdár, and at an equal distance from the limits of Sístán as it is to-day. A deep canal running west irrigated the fertile plain of Hauzdár, the main stream flowing north under the name of Rud-i-Nasru. On its banks were the famous cities of Shahristán and

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* Abstract of paper read by Major P. Molesworth Sykes, C.M.G., before Section E, British Association, Belfast.

Zahidân. Towards the close of the 14th century Sístân was invaded by Timur or Tamerlane, who destroyed the dam, and thus reduced the Hauzdâr plain to a waterless desert.

The Helmand, while still keeping to the Rud-i-Nasru, created a second branch encircling Sehkuha, which had not hitherto been inhabited. There was apparently no other change until early in the nineteenth century, when the whole volume of water united to carve out a channel further east, to the west of the village and mound of Nád-i-Ali. As cultivated Sístán was thereby left high and dry, the Rud-i-Sístán was cut a little to the north of Sehkuha—a task of great magnitude. This was the state of affairs when Sir Frederic Goldsmid made his award; but in 1896 the Helmand began to forsake the Nád-i-Ali Channel, and struck out a new course between it and the Rud-i-Nasru. This is now known as the Rud-i-Perián, which was a fine river when the author crossed it on a reed raft in 1899. It is anticipated by the grey beards of Sístán that the wayward Helmand will finally return to the ancient Rud-i-Nasru.

The Lut, undoubtedly the salient characteristic of Persian physical geography, is believed to have been in early times an inland sea, which theory is supported by the presence of the active volcano of Sarhad, the extinct volcano of Bazman, and many legends. Careful inquiry has led the author to believe that the name Lut properly applies to the whole of the great desert of Persia, including the so-called Dasht-i-Kavir in the north and the Dasht-i-Lut in the south, and that its saline portions are known as Kavir, which is undoubtedly the Arabic word *kafr*, signifying a saline swamp. As regards the term Lut, the guides point out fantastic bluffs, resembling forts, mosques, or cathedrals, and explain how they are ruins of cities which the Almighty destroyed, as was the case with the cities of the plain, from which Lot escaped with so much difficulty. Furthermore, Luti, although now used to designate a buffoon, formerly meant a Sodomite. It would seem that this great waste of Persia has become associated (most appropriately) with the name of Lot, Abraham's nephew.

The author concluded his paper with some remarks on the trade routes, and on the telegraph line which is being constructed across Persia, showing how, in every case, direction was determined by geographical features.

General Notes.

PHOTO-ENGRAVING AND LITHOGRAPHY.—The eighth session of the London County Council School of Photo-Engraving and Lithography, Bolt-court, Fleet-street, will commence on Monday, 29th inst. The courses of practical instruction are arranged to suit the following craftsmen:—Photo-Engravers, Photo-Lithographers, Photographers, Lithographers, Designers, and Draughtsmen. Only those engaged in the trade are admitted.

REPTILES OF BARBADOS.—In the *Agricultural News* reference has been made to the two harmless snakes that at one time were fairly abundant at Barbados. The other reptiles met with in the island are four species of lizards. The more common of these is the pretty green lizard (*Anolis alligator*), which occurs generally in the Lesser Antilles, and probably was introduced thence to Barbados. The Gecko or "Wood Slave" (*Hemidactylus mabuia*), found in shady, moist localities, has almost world-wide distribution in the tropics. Another lizard, locally called "Scorpion" (*Mabuia agilis*), is said to be rare in Barbados. Colonel Feilden obtained specimens of it from Graeme Hall Swamp and "Chancery Lane" in 1888. It occurs over the greater part of tropical America. The largest and handsomest lizard in Barbados is what is known locally as "Guana," probably a corruption of Iguana. This is found generally in the West Indies and South America. Colonel Feilden, in 1889, mentioned the curious fact that all the specimens of this lizard in the British Museum were females, and that probably the male was undescribed. The mongoose has greatly reduced the numbers of this lizard, and probably, before long, it will entirely disappear.

HUNGARIAN MARBLE. — Hungarian papers have recently reported that in Gyergyo, a town in one of the Transylvania counties of Eastern Hungary, there is great poverty and famine among the Szekler inhabitants, and yet that district, according to a recent report of the American Consul at Budapest, is full of a rich material that is in constant demand, viz., marble. Upper Italy now supplies the world with considerable quantities of marble, and it is also found in the districts of Laaz, in the Tyrol, a province of Austria, and in Silesia, one of the northern provinces of the same Empire. Transylvania, the eastern portion of Hungary, is rich in the marble of the finest quality, yet Hungary imports £100,000 worth of marble every year, mostly in the form of grave-stones. The Hungarian stone industry has developed but little, though there is a steady demand for everything in the marble line from the neighbouring country of Russia. All its churches, palaces, and public buildings are profusely decorated with marble, which, owing to the lack of Russian quarries, has to be imported. As there are no high-grade quarries in Servia, Bulgaria, or Turkey, the opening for Hungarian marble is considered promising. The results obtained with Hungarian marble in the new Parliament House and Palace of Justice at Budapest are said to be admirable. It is proposed to put the Szekler population of Transylvanian Hungary into possession of tools of the finer sort, such as are required in marble work. There are already two State industrial schools in Szekelz, and these will be supplemented by workshops in the district where the marble is found. The output will, it is believed, finally exclude the foreign product.

Three Color Reproduction.

“ INSE

Photographed direct from the natural objec

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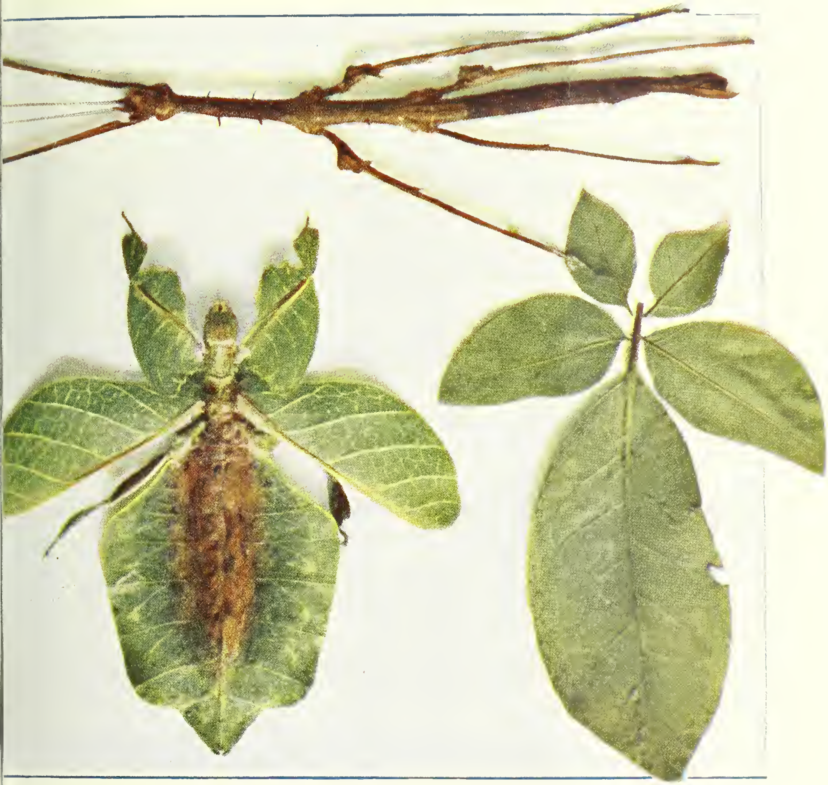
Supplement to the Journal of the Society of Arts. Oct 3rd., 1902.



André & Sleigh, Ltd., Bushey, Herts

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' Educational Co., Ltd.

Journal of the Society of Arts,

No. 2,602. Vol. L.

FRIDAY, OCTOBER 3, 1902.

All communications for the Society should be addressed the Secretary, John-street, Adelphi, London, W.C.

Notices.

THREE-COLOUR PRINTING.

With the present number of the *Journal* is published a supplement, consisting of a specimen of Three-Colour Printing by Messrs. André and Sleigh, in illustration of Mr. Geddes's Cantor Lecture.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a prize of £20, for competition amongst students of the Schools of Art of the United Kingdom, at the Annual National Competition to be held in 1903.

The prize is offered to the student who obtains the highest awards in the following subjects :—

(*a.*) A finished drawing of imperial size from the nude living model.

(*b.*) A set of time studies, on a small scale, from the nude living model, executed in a short time, of varied shortly sustained poses (mounted on not more than two imperial size mounts).

(*c.*) A set of studies of hands and feet from the living model (mounted on not more than two imperial size mounts).

(*d.*) Drawing from the life, including memory life drawing, done at the Examination on May 9, 1903.

No student will be eligible for the award who does not pass in the Examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The recipient of a prize awarded under this trust in 1892, 1893, or 1896, cannot compete again.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Board of Education, South Kensington, in April, 1903. Each competing drawing must be marked "In Competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Board of Education.

Proceedings of the Society.

CANTOR LECTURES.

PHOTOGRAPHY AS APPLIED TO ILLUSTRATION AND PRINTING.

By J. D. Geddes.

Lecture III.—Delivered March 17, 1892.

Trichromatic photography and three-colour printing is the latest and by far the most important development of photography in the whole range of processes of illustration invented or evolved during the past half century, and it is a subject that I approach with some diffidence. It has been dealt with in this historic hall on several occasions by giants in the world of modern research, men who have devoted years of investigation to every theory and every detail. I hope that it will not be considered presumption in me to attempt to raise my voice on such a matter and in such a place. I am invited to place before you my version of these processes, and I will to the best of my ability endeavour to explain the principles and working of the three-colour process from the practical point of view of a worker, but I will not try to put before you or to make you understand the formidable theories surrounding and enveloping the whole question of colour analysis, of Fraunhofer lines, molecular swings, the undulating theory of light, or the like ; not that I, for a moment, wish you to understand in this art or science of the photographing of colours that theory goes for little or that practice is everything; without theory the process as it now stands would be a vain thing and we workers have no other feeling than gratitude towards those patient investigators who have found out and established rules and measurements for every operation, the exact spectrum colours to be used, the proper methods of sensitising plates, the relationship between spectrum colours and pigments, the tabulating of exposures for each colour and light condition. In almost every problem which may be presented to the experimentalist or workman, all these things are recorded and are to him who reads, power.

Having stated this much, I must explain that the general principles upon which trichromatic or three-colour photography is based are as follows:—It is an accepted theory in the case of every object in nature or art exhibiting colour in any form or combination, that colour or colours result from the three primary colours which form white light, alone or in combination. These primaries I may name roughly, red, blue and yellow. [Mr. Symonds will now by means of the photo-spectroscope make a photograph before you of the spectrum of a beam of light given by the electric arc, the little experiment will be instructive in two ways, it will enable you to see the spectrum on the focussing screen of the camera, and the result of the photograph will show the effect of the different colours and their colour values on the photographic plate.] I may as well say at once that the three colours named now as the primaries are not scientifically red, blue, and yellow, they are, to be more exact, red, green, and purple violet, but these latter spectrum colours cannot be employed successfully in the form of pigments in the printing press, and as that is the principal object in view in this paper it will simplify matters if I speak of these primaries all through as red, blue, and yellow. It is known to all of us that the white light of daylight or the sun is composed of and is the result of a combination of coloured light; analysis by the spectroscope shows it to be composed of all the colours of the rainbow, yet all these colours may be reduced to three, the ones I have roughly named, red, blue, and yellow. If three glasses are coated with films of the three primary colours and by means of a triple lantern are projected on a white screen, the three disks on being superimposed will produce white light, that is to say, the three separate colours projected one over the other will give us pure white. It is interesting to note and necessary to remember, that the same colours in the form of a pigment or ink, superimposed or printed over each other on paper, form not white but black.

The principles of these interesting phenomena of light were laid down in 1861 by Clerk-Maxwell, and they have been elaborated since by many investigators. A French scientist named Ducos du Hauron early applied the principle to photography, and since his day we have had Ives, of Philadelphia, Vogel, of Berlin, Lipmann, of Paris, Wood, in America, and in this country, Abney, Joly, Sanger Shepherd, and many others.

Having established the principle that all combinations of pigmental colour in say, for instance, a painting, are formed out of the three primary colours, the next step for the photographer is to obtain negatives from the painting, which, so to speak, automatically dissect out from the original each separate colour mentioned, and so make three distinct photographic records of the reds, blues, and yellows entering into the composition of the subject. This result has been attained by the employment of plates which are so sensitised as to be affected specially by two only out of the three primary colours. The action is controlled in photography by the use of what are known as *light filters*, which are transparent screens of coloured pigment, placed before or behind the lens, which admit at will *any two* of the three primary colours to the sensitive plate and absorb the other one. The *rationale* of the process may be described thus: — The negative used for printing the red colour sensation is made to see yellow and blue combinations, and is colour blind or insensitive to red and its combinations. The blue plate sees reds and yellows only and their combinations, and is colour blind to the violets, and the yellow negative sees red and blue only, and is colour blind to yellow. Having obtained these negative records of the colour analysis of the subject, and, supposing the exposures are correct and the colour value in each properly balanced, it only remains to convert the three photographs so obtained into printing surfaces by any process rendering half-tones, say Collotype or Half-tone blocks, and from this printing surface to reproduce the separate colours impressed in printing ink in their own colours on paper. The block representing the yellow is printed first in yellow ink; over this picture is accurately registered the block representing the red, and printed in red ink, and finally the block representing the blue is printed over the yellow and red impression with blue ink; the result will be found closely to approximate to the original in all its colours and combinations of colour, from the palest tints to solid black.

This, shortly stated, is the whole process of trichromatic reproduction. I will now try to explain in a little more detail how these results are arrived at. The process is yet young, and though the theory is perfect, the practice is not altogether so. Many difficulties have to be contended with, amongst which, I may mention that we have yet to discover plates and sensitisers which will respond accurately to the spectrum curves laid down for each colour sensation. We have also still to find light filters which will effectually stop the action of light rays which are not wanted. Then the interposition of the grained screen required for the production of a surface printing block degrades and flattens the gradations for the picture, rendering skilled artistic aid necessary in the etching of the plate. The selection of standard printing ink colours, is a further element of trouble, because inks of great purity and brilliance are necessary, and it would seem as if pigments of the requisite quality are difficult to obtain, unless more or less fugitive colours are employed. There is hope in this direction, however, and our best ink makers are making laudable efforts not only to supply a reliable standard, but are gradually nearing the ideal as regards purity and permanence of colour.

I have stated that the plates used for trichromatic photography must be specially treated so that they may be more or less sensitive to light from different sections of the spectrum. Ordinary plates sensitised with bromide of silver are affected principally by the blue violet rays, and a great deal of patient research has been devoted to the finding of substances which will control and vary this action so that other rays may exert an equal reducing influence on the salts of silver. It has been found that certain dyes added to the collodion or emulsion have a controlling influence in the required direction, and this idea has been followed up until there are now a number of colour sensitisers and colour sensitive plates on the market prepared on scientific principles and answering most requirements. As just mentioned ordinary untreated photographic plates are most sensitive to the blues and violets of the spectrum. A solution of erythrosine dye renders the plate sensitive to green and yellow, and a solution of cynanine dye alters the range of sensitiveness through the orange up to the red. The spectrum plates made by Messrs. Cadett and Neal and the orthochromatic plates prepared by M. Lumière, also the collodion emulsions supplied by Messrs. Penrose and Dr. Albert, are all excellent for the purpose of trichromatic photography, and it is not now so necessary for the experimentalist to sensitise his own plates as was the case some few years ago.

The light filters for making the separate colour negative may be in two forms, liquid or dry. The liquid or wet filters are made of dyes in solution held in tanks or cells of optically flat glass. Dry filters are made of similar dyes in a solution of gelatine or collodion with which optically worked glasses are coated, dried and sealed with a cover glass to prevent injury. The latter are found most convenient for working, though it is held by some experts that superior results are given by the wet filters. The dyes and pigments used for making light filters are numerous, and no particular standard has yet been settled; each plate manufacturer and operator recommends or adopts some modification which suits his particular working, and in their hands the end seems to justify the means. In my experience I have found that dyed collodion filters, if carefully made, answer every purpose.

A collodion is made containing five or six grains of pyroxyline to the ounce of mixed alcohol and ether, and the dyes are dissolved in alcohol and are added to the collodion until the solution is deemed of sufficient strength for coating the plates. Dyes that will not dissolve in alcohol are dissolved in water, and the glass plates, coated with plain collodion and washed, are dipped in a bath of the aqueous dye until the film of collodion is saturated with the requisite strength of colour. It is generally necessary to coat two separate glasses for each colour filter and to cement the two together face to face with Canada balsam. Sometimes coloured glass is used in combination with dyes, but there is no particular advantage in doing so, because the dyed films are less liable to interfere with the action of the lens than glasses which are coloured right through. In practice, for three-colour block printing, the filters are varied in the colours and strengths so as to adapt them to the particular standard of printing ink used for printing the blocks.

The following dyes or their equivalents form a basis for most filters for three-colour work :—

For the red printing negative..	2	Brilliant yellow.
	1	Brilliant green.
For the blue printing negative..	1	Cochineal red.
	2	Brilliant yellow.
For the yellow printing negative	2	Napthol green.
	1	Methyl violet.

Glasses are coated with each of these colours and cemented together in pairs in the order given. One colour usually predominates over the other, for example, the green used in the red record is the dominant colour, and the red used in the blue record dominates the yellow.

The sensitive plates used with these light filters may be either collodion emulsion or gelatine dry plates, modified, as I have already stated, in their scale of colour sensitiveness so as to be specially active to only two of the primary colours in each case.

The plate for use with the "green-yellow" screen must be sensitive particularly to the green and yellow rays and not at all to the reds, which are not required in this record. The plate for the "red-yellow" screen must only be active to those rays and not to the blues, whilst the plate for the "violet" screen must see blue and red and be colour blind to the yellows.

I have mentioned that there are several excellent grades of commercial plates available, which fulfil with fair accuracy the theoretical conditions just named, as regards colour and sensitiveness. They are all carefully made, and provided they are not stale, the operator is safe with almost any of the makes—Cadett's, Lumière's, Ilford chromatic, or Edwards, or collodion emulsion may be substituted if the dark-room conditions are complied with.

I do not propose to go through the operations of photographing, more than to say that in addition to the precautions ordinarily taken with rapid dry plate work, there are others to be observed in consequence of dealing with plates which will instantly fog if exposed to the rays of the customary ruby dark-room lamp. Only the faintest red light must be used for the red and yellow printing plates, whilst, for the development of the blue plate, a green light must be used, and very little of that. The best means of all is to develop in the dark, first carefully working out the exposures and developing time by Hürter and Driffield's tables of factors. I would also commend Sir W. Abney's colour sensitometer to those who are testing or working plates and screens of unknown quantity. It is a *sine quâ non* that the development of three colour plates should be exactly right, intensifying and reduction afterwards may be resorted to to correct under or over development, but this course is never quite satisfactory, the proper balance of colour value is disturbed, and troublesome corrections may be necessary before the printing plates are deemed satisfactory.

It is of course one thing to prepare plates and colour filters which will work accurately with spectrum colours, but it is another matter to deal with the reproduction of objects or pictures containing compound colours (sometimes two or three painted over one another). In the case of water-colour drawings, it is frequently puzzlingly difficult to account for the apparently false effects given in the colour negatives, though photographed under conditions which seem perfect; but a little consideration shews how possible it is for errors in colour values to be recorded. White light is always present in photographing any object, and is reflected in a greater or less degree from every colour, there is also the paper or canvas on which the drawing is made, giving out white light in proportion to the strength or weakness of the wash of colour upon it; this agency will always cause a disturbance of colour values, and has to be reckoned with in the most perfect process of colour reproduction. So that, save in exceptional cases, you will understand why it is necessary to aid the colour plates by careful retouching and etching. This artistic assistance applies more particularly to the preparation of blocks for the printing press.

The camera for three-colour photography should be constructed with a view to the greatest rigidity and fixed to a solid stand, which, when in position, can be securely fastened down to the floor of the studio. The lens must be of the most rapid type, and for direct working on plates through a half-tone screen will require a prism attachment to reverse the image. The colour filter may be behind or in front of the lens combination; in front is most convenient, and a simple slide arrangement attached to the hood of the lens or prism is all that is needful.

Having succeeded in making a set of trichromatic negatives, the next important step is to obtain prints from them on paper or glass in the proper colours, and to superimpose one over the other in order that the reproduction of the subject photographed may be complete.

Happily it is not necessary for the amateur or experimentalist to have a photo-engaving installation to attain this desirable result, and we have to thank Mr. E. Sanger Shepherd and Mons. Lumière for having devised methods of printing from three-colour negatives on their films of sensitised gelatine, which are afterwards dyed with the primary colours. When these films are dried and cemented together (the whole process, I may say, is at once simple and ingenious) the finished results are in every way interesting and charming. The processes are within the reach of any one possessed of true photographic patience, and I cordially recommend them to your consideration.

The process of translating three-colour negatives into blocks for the printing press, and the subsequent production of copies of the subject in colours on paper, is already a scientific industry both in this country and abroad, and it marks a new epoch in artistic illustration. There are two methods in vogue for the making of colour blocks from the negative records. The first is called the "indirect" process, and differs from the "direct" process, in that the colour negatives are made without the interposition of the mechanical screen grating, consequently transparencies on glass must first be made of the three separate negatives. From these transparencies, negatives with the indispensable grain are made, and are printed on copper or zinc for etching in the ordinary way.

In the "direct" process, the original colour negative has the half-tone screen placed in position before it during the exposure, and the result is a grained negative which can be printed direct on metal, without going through the operation of preparing transparencies and grained negatives from them, The advantage of the "direct" method is a saving of two operations, and the disadvantage is the increased exposure caused by the interposition of the screen grating.

It is necessary to explain that the mechanical ruled screen cannot be used at the same angle for all the plates. The usual angle is 45° for an ordinary block by the half-tone process, but if all three negatives were printed with the grating at the same angle, two disagreeable things would occur. First, the colours of the three separate printings would be, so to speak, entangled, one dot of colour would be printed over the top of the other, and would be lost (to get the colour-value in the tones of a picture in dots it is essential that the spots of colour should be side by side and not superimposed); second, there would be a curious *moiré antique* pattern introduced by interference which would utterly spoil the picture. These troubles are avoided by arranging the angles of the screen grating each about 30 degrees to the other, one at 15, another at 45, and the third at 75 degrees.

The negatives are printed on copper in enameline, and etched in relief by the half-tone block process already explained. The etching of the plates is carried out by artists who not only know how to deal with the mechanical portions of the work, but have a knowledge of colour and colour values, and on their skill and knowledge much depends as to the ultimate success of the reproduction.

The printing of the blocks is carried out in the ordinary printing press, and the plates are treated in all respects as the usual type block, but it is requisite that the printing press used for this purpose should be of the very best construction, and capable of being made to register one printing over the other with the utmost accuracy. The block for the yellow printing is first arranged in the press, and impressions are taken in yellow ink on paper having a fine texture and surface. The red printing block is next fixed in the same position in the press as was occupied by the yellow, and is inked with red ink. The impression is made over the previously printed yellow, and is registered, so that it fits exactly over every part of the yellow picture, the result being an impression containing all the yellows and reds of the original. The blue printing plate is next placed in position in the press, and the same precautions observed as to the registering. After inking the plate with blue ink, the impression is pulled over the two printings in yellow and red already made, and the result is the complete picture containing every shade of colour of the original, no matter whether the original is from nature, a painting, water-colour, object of art or commerce.

I wish to acknowledge my indebtedness for kindly assistance given by Mr. Howard Farmer and Mr. Symmons, of the Polytechnic Institution; to Messrs. Cassell and Co., Limited, for originals and specimens of three-colour plates executed for them by André and Sleigh, Limited, of Bushey; to Mr. E. Sanger Shepherd, of Gray's-inn-passage; and Mr. T. K. Grant, of the Lumière N.A. Co., of 78, Victoria-street, for the fine examples of trichromatic lantern pictures exhibited to you.

[The example of three-colour printing accompanying the present number of the *Journal*, entitled "Insect Mimicry," has been reproduced by the method described in the foregoing paper, that is to say, the subject was photographed direct from a group of the actual insects and leaves (arranged by McDougall's Educational Company of Edinburgh) and from the colour negatives so obtained half-tone blocks were prepared and printed, giving the result shown.]

Miscellaneous.

*INVESTIGATION OF THE UPPER ATMOSPHERE BY MEANS OF KITES.**

On the invitation of the Committee appointed by the Royal Meteorological Society, it was decided to hold joint committee meetings, and such meetings were held on October 25th, 1901, January 14th, April 8th, and May 7th, 1902.

The sum of money at the disposal of the joint committee, viz., £75, granted by the British Association, and £25 by the Royal Meteorological Society, not being sufficient to meet the necessary expenses, it was decided to apply to the Meteorological Council and to the Government Grant Committee of the Royal Society for further assistance. The Meteorological Council kindly undertook to supply the necessary instruments for a base station, and the Government Grant Committee have made a grant of £75.

Inasmuch as there is considerable risk of damage and also of injury to life should a long wire carrying one or more kites break loose in a thickly populated district, it was decided to make observations in some thinly inhabited part, and, if possible, over the sea, so as to reduce this risk to a minimum. Since, further, we have no information whatever as to the vertical temperature gradient over the great oceans, and this knowledge is of supreme importance for theoretical meteorology, it seemed desirable to work on the west coast, since the prevailing westerly winds must make observations taken there equivalent, as a rule, to those taken over the open sea. It was also thought that if a fair number of observations could be obtained at the height of Ben Nevis, but somewhere on the coast in the neighbourhood of Ben Nevis, some light would be thrown upon the question as to how far the temperatures taken on a mountain summit differ from the temperatures of the free air in the surrounding districts at the same level.

With these objects in view I was commissioned to obtain the necessary apparatus and erect it at some convenient spot on the west coast of Scotland.

The apparatus has been obtained, and is now (June 17th) erected on a small island at Crinan, a small village lying at the north end of the Crinan Canal, about thirty miles south of Oban.

The apparatus consists of—

I. Winding-in apparatus for the wire.
II. Engine and boiler to drive the same.
III. Sets of kites.
IV. Twelve miles of wire.
V. Instruments.

I. The winding-in apparatus carries two reels of 16 inches diameter and 4 inches broad, to hold the wire, and two strain-pulleys to reduce the tension of the wire before it is wound. The wheels run loose on the same shaft that carries the strain pulleys, but there is an arrangement by which they are pressed automatically against the strain-pulleys to increase their turning moment by friction against the outer rim of the pulley, or against the fixed frame of the apparatus to reduce the moment. By this means an adjustment of the tension is obtained, and the risk of the reel being crushed by the tension of the many turns of the wire is avoided.

II. *Steam-engine.*—This was obtained from the Reading (U.S.) Road Car Company. It has four single acting cyclinders of 2½-inch bore and 4-inch stroke. It weighs about 60 lb., and is nominally of 6 horse-power. The cost was £25.

The choice lay between a steam-engine and a petrol motor. The steam-engine was chosen for the following reason. It is not desirable to draw in a kite wire when the wire is near the breaking point at a uniform speed, because the speed of winding in is equivalent to an increase of the wind velocity, and greatly adds to the strain. Advantage should be taken of the intervals between the gusts to take in the wire, and this a steam-engine without a dead point does automatically. Winding in a kite during a gale on June 14th the engine acted perfectly, running fast whenever the tension of the wire slackened, and slowing down or even stopping entirely when the tension was increased by a gust. Of course, the precise tension at which the engine stops is adjustable within wide limits by adjusting the steam pressure in the boiler.

The boiler was obtained from the Britannia Company, Colchester, at a cost of £25. It is fired by ordinary lamp oil (paraffin), of which it uses about a gallon an hour.

III. *The Kites.*—These are described in Symons's *Meteorological Magazine* for April, where also the reasons for not using the Blue Hill kite are stated.

Of these there are five ready for use and the materials for making six or eight more. There are also two kites designed by, and purchased of, Mr. F. S. Cody.

Both kinds, so far as my present experience goes, seem entirely satisfactory. Mr. Cody's kite flies at a rather better angle, but does not seem to be quite as steady as the other. Indeed, the angle of the Cody ite when made of silk and light bamboos is reiarkably good.

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* Report of a Committee of the British Association, consisting of Mr. W. N. Shaw (Chairman), Mr. D. Archibald, Mr. C. Vernon Boys, Dr. A. Buchan, Mr. W. H. Dines (Secretary), and Dr. H. R. Mill, acting in co-operation with a Committee of the Royal Royal Meteorological Society. From notes by the Secretary. Read before Section A, Belfast.

IV. *The Wire.*—This is of the usual kind, but I ave been supplied with eight miles in one piece by Iessrs. Brunton and Son, Musselburgh, N.B.

V. In addition to the well-known Richard instruıents which have been ordered, it seemed desirable o obtain, if possible, something cheaper, since the isk of losing the instruments is not small. I am xperimenting with a cheaper form. I also hope to btain correct determinations of the maximum height ind the temperature at that height in the following nanner. If a glass tube of uniform bore, sealed at he top, but with the other end under water or quicksilver, were sent up with a kite, it would, assuming constant temperature, give the maximum height, for he air in the tube, under the decreased pressure, would expand and bubble out, and on the descent water would rise in the tube, and the height of the water or quicksilver would give the minimum pressure, and hence the maximum height. This is assuming constant temperature. But if an exactly similar tube were also used containing saturated vapour of alcohol two equations would be obtained, from which the two unknown quantities, temperature, and height can be determined. I hope to perfect this method, since there are many occasions on which a kite and a couple of glass tubes might be risked when one would hesitate to send up instruments costing £20.

The apparatus above described is now in use every day when the wind is suitable, but there seem to be very many days during the summer when a sufficiently strong wind does not occur. A velocity of about fifteen miles per hour is necessary, force 4 on the Beaufort scale; but the upper limit at which the kites will fly has not yet been determined.

The Chairman contributed an addendum with a Table of flights. From June 19 to August 20 sixty-eight flights were obtained, the greatest height being attained on August 20, viz., 11,450 feet, when 21,350 feet of wire were used.

For the period extending from July 8th to August 22nd a steam-tug was obtained, and the apparatus mounted on the deck. This arrangement was found to give much more effective control over the experiments, and rendered possible observations in light winds that would not have lifted the kites on land.

The observations will be discussed, and the results prepared for publication in the course of the ensuing year. The Committee consider that the work that has been completed is amply sufficient to show that the apparatus and methods are effective for securing valuable information as to the upper air in various conditions of weather. There are some points in which it seems desirable to attempt to improve the recording apparatus in order that the readings may be more definitely checked, and the Committee think it desirable for the experiments to be continued for another year, during which it may be possible to arrange the flights to obtain precise information regarding the distribution of temperature and humidity in specific conditions of weather in order to examine the physical processes taking place in the upper air corresponding to weather changes noted on the surface.

The kites and apparatus for winding in, with such modifications as experience has suggested, but with little additional cost, will be available, but it is of great importance to be able to employ a tug, in order that the investigation of the upper air may not be entirely dependent upon windy weather.

GOLD OUTPUT OF GREAT BRITAIN.

The following particulars of the gold produce of Great Britain were communicated to the *Mining Journal* by J. Malcolm Maclaren, B.Sc., F.G.S.

Though records of the gold yield of the British Isles have been kept for more than 40 years, there has not previously been published returns showing the total gold yield of the British Isles. The following figures show the output of the four components of the United Kingdom:—

England.—In Cornwall, though nuggets have been picked up in the course of tin streaming operations from time immemorial, the yield has never been sufficiently great at one time to justify record. During 1852 and 1853 the neighbouring county of Devonshire produced £581 5s. 1d. worth of gold from the Britannia and Poltimore Mines, near South Molton.

Wales.—The gold of North Wales was discovered about 1843, but it was not until 18 years later that gold in any quantity was raised. From 1861 to 1867 the yield was very satisfactory, but it fell away very rapidly, and for 20 years the yield was very small, some years, indeed, being blank. In 1888, however, the discovery of the rich Gwynfyndd lode gave an impetus to Welsh gold mining, which is not yet exhausted. The record yield is that for 1900, when gold to the value of £52,147 was produced. The value of the yield up to 1887 was £71,692 13s. 11d., and that from 1888 to 1901 was £208,855.

Scotland.—The first recorded gold field in Scotland was that of Crawford Moor, discovered about 1511, and worked spasmodically for a century, the last systematic workings being those of Stephen Atkinson, circa 1616.

At the present time it is, of course, impossible to estimate with any approach to accuracy the quantity of gold produced by the Crawford Moor alluvial deposits during the 16th and 17th centuries. Pennant, without quoting authorities, says:—"In the reign of James IV. and James V. vast wealth was procured in the Leadhills from the gold found in the sands washed from the mountains; in the reign of the latter not less than £300,000 sterling." Dr. Lauder Lindsay, with authorities equally obscure, places the yield still higher—viz., £500,000. In a matter which, from the conditions of working and from the lapse of time, must necessarily be of considerable uncertainty, it is advisable to accept those authorities who speak with the most immediate knowledge of the subject. In this case the only authority is a letter of one George Bowes, who had, for a time, charge of the sluicing operations at Leadhills. Bowes, writing about 1605, and speaking of a yield which had taken place during his own and part of the preceding generation, says that "the golde gotten thearin is of greater value than one hundred thousand pounds." This estimate is probably rather over than under the mark, though indeed much of the Scottish coinage of the time was minted from native gold.

The gold deposits of the Kildonan, near Helmsdale, in Sutherlandshire, were discovered in November, 1868, and were worked more or less vigorously until the end of 1869. During the short period that these gravels were worked, royalty was paid on £3,000 worth of gold, but as the temptation to conceal the greater portion of the gold discovered must have been irresistible, it is probable, as estimated by Dr. Joass and others, that the total amount recovered by the diggers was not less than £12,000.

Ireland.—In September, 1795, the gravels of the Ballinvalley stream, which flows into the Ovoca River, at Woodenbride, County Wicklow, Ireland, were found to be auriferous. A "rush" of peasants took place, and work with the crudest of appliances was carried on for six weeks, when the news came to the ears of the authorities, and the further operations for the recovery of the alluvial wealth of the Ballinvalley, or Gold Mines River, as it came to be called, were carried on by the Government of the day. Owing to the outbreak of the rebellion, operations were suspended in May, 1798, and were not resumed till 1800. In 1803 the gravels became so poor that the directors advised an abandonment, to which recommendation effect was immediately given. Since that time the valley has been spasmodically worked by the peasants and by various companies. The folllowing table, computed by Mr. S. H. Kinahan, of the Irish Geological Survey, who has devoted considerable attention to the subject, shows the approximate gold yield of the district:—

Worked by	Duration of works.	No. of Ozs.	dwts.	grs.	Value. £	s.	d.
Peasants	Sept. & Oct., 1795	800 to 2666			3,000 to * 10,000		
Government ...	1796–1803	944	4	15	3,675	7	11½
Peasants	1803–1839	5,000	0	0	20,000	0	0*
Crockford & Co.	1840	600	0	0	1,800	0	0
Carysfort Co....	1862–1866	52	11	5	203	0	0
F. Acheson	1876–1879	14	3	0	60	0	0

The total produce from the Ballinvalley stream is estimated at from 7,440 ounces to 9,390 ounces, worth from £28,855 to £36,185; but, as will be seen, the estimated amount bulks very largely in these totals, and the total produce is probably somewha less than that stated.

The total yield of gold from the British Isles may with the exception of the quota from the Leadhills in Scotland, therefore, be computed with sufficien approach to accuracy to give considerable value to th estimation:—

	£
England (North Molton, 1852-3)........	58
Wales (Dolgelly area, since 1844)	281,49
Scotland (Leadhills area, 1511-1616)	100,00
Sutherland (1868-1869)	3,00
Ireland (County Wicklow, 1795-1879) ..	21,85
Total gold yield of British Isles	413,93

Of this sum it will be seen that nearly all, with th exception of that from the Leadhills, has bee obtained during the last century, and slightly mor than half of it (£208,855) during the last 14 years.

*TRUSTS: FROM THE POINT OF VIEW OF ECONOMICAL THEORY.**

The principal object of the paper is to attempt to estimate the effect of a general Trust system on the chief economic categories; namely, production, prices, profits (including interest), and wages.

In it I have endeavoured to show: (1) That production under a Trust system would be largely increased on account of certain economies and greater returns; and that whether it would be increased after a generation or in the end would depend mainly on two considerations—whether inventions and discoveries were duly encouraged, and whether the practice of "limiting supply" were resorted to or not. (2) That as regards prices, while the Trusts would have power of fixing them at discretion, and in some cases would be much tempted to raise them beyond what competition-prices would have been, that nevertheless their sense of self-interest, if not of pecuniary interest, would be a check on the most important cases; and that while there would probably be a difference between competitively-determined and monopoly-determined prices, unfavourable to certain classes of consumers, it would be less than some enemies of Trusts apprehend, owing in part to the elements of monopoly at work at present in determining prices. (3) That profits and the rate of profits as understood by Mill, and consequently dividends or profits *minus* wages of manager and insurance, would be raised, and raised more because manager's salary is a fixed amount; but that some of the owners of capital would not be benefited by the rise on account of the shares taken by promoters and underwriters; that, as closely connected with profits, though also obeying a law of its own, even under ionopoly, interest would also be raised at first; but vhether it would continue raised would depend on ertain things which would probably not be the same nder a competitive as a Trust system: namely, the tate of industrial stability and the co-relative state of he speculative spirit, the state of invention, of oreign trade, and of the extent of foreign investnents to develop production in other countries. 4) That the question of wages, so difficult even inder the present system, half competitive, half of ombination, would not be more difficult on the vhole under a Trust system; and that self-interest vould prevent a reduction of wages below former evels, from the increasingly clear perception of inelligent managers that good labour is worth high vages, and inferior labour often "dear at the price," hough low; that accordingly wages might, *ceteris baribus*, be as high as under the existing order, hough Trade Unions would occupy a less strong osition than at present to enforce their desires by a strike, without being entirely helpless; that the employment of the working classes would probably be more steady, though their sense of independence might not be so strong.

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* Estimated.

* Abstract of paper read by Prof. W. Graham before Section F, British Association, Belfast.

These general theoretical conclusions are afterwards compared with the results of some of the more notable American experiments in Trusts, as gathered from American economists, with a view to test their soundness and applicability to real cases that may arise, especially in countries under a system of Protection, which give a much fuller scope to the evolution of Trusts.

THE ELECTRO-TECHNICAL INDUSTRY IN RUSSIA.

Until recent times the electric industry has made extremely slow progress in Russia. Unfavourable circumstances have combined to impede the industry and prevent it from reaching the level found in other countries. One of the principal causes of this lack of development was the absence of schools in which to educate electricians. Of late, however, the Government, private companies, and individuals have opened special schools for electricians, and in addition, the special art and artisan schools have introduced an electro-technical course. The influence of these special schools and courses has not been slow to make itself felt, and of recent years the electric industry has made immense progress. Many towns and cities are lighted by electricity, and electric tramways are numerous. Nearly all the large factories and industrial establishments have adopted electric lighting, and have applied electricity to the distribution of motive power. Electric energy has also been utilised in mining enterprises, particularly in the south of Russia. The use of electricity in soldering, in the extraction and refining of metals, as well as in certain electro-chemical works, and in the production of carbons and hydrochlorites, is now well developed in Russia. With the increased and varied applications the demand for apparatus has grown enormously, and dynamo machines, motors, transformers, lamps, &c., find a large sale. There are, says Consul Heenan, of Odessa, but two factories in Russia which produce electro machines and lamps, and in consequence most of these are imported. Germany and Switzerland furnish the largest number, next comes England, and then follow the United States, France, and Belgium. A few years only have passed since such cities as St. Petersburg and Moscow began to have their streets lighted by electricity. At present there are fifty towns wich employ the electric light, and many other places are erecting the necessary apparatus. The rapidity with which the use of electricity has spread at St. Petersburg will serve as an example of the popularity of this manner of lighting. The first central station was installed in the city in 1881, and the power of that station was about 250 kilowatts. Until 1885 there were only a few stations opened, and the power increased very slowly. After that year the power of the stations and their number grew rapidly, and in 1898 there were 169 stations, having altogether 29,000 kilowatts of power. In 1898 and 1899, three additional central stations were constructed in St. Petersburg, and at the present time, the power of all the central stations taken together (exclusive of the private stations) reaches 15,000 kilowatts, and work near completion will raise the power at these stations to 30,000 kilowatts. The number of private stations is about three hundred, and these have a total power of more than 39,000 kilowatts. St. Petersburg is lighted by means of arc lamps in the principal streets and by incandescent lamps in streets of less importance. In Moscow and in other towns, both large and small (particularly those situated in the industrial region), the use of electricity has made no less rapid progress than in St. Petersburg. In the beginning, the stations constructed were almost all for the continuous current, but, in the later ones, the preference was for the monophase and triphase alternating current. Electricity is also coming largely into use for tramways. The first electric tramway built in Russia was the one at Kief, which dates from 1893. In 1898, 45 cities had constructed such lines, their length exceeded 312 miles, and nearly 10,000 kilowatts were in use for the motors. The number of motor cars was about three hundred, and there were many cars without motors. Most of the tramways are worked by a continuous current. The total length of wire for the electric tramways in St. Petersburg is estimated at 1,875 miles. Air conductors and underground conductors will be used, and in the principal streets, accumulation traction. Nearly 400 motor cars will be in use, and 300 without motors. Other cities also contemplate the employment of electricity on a large scale, and plans are under consideration for its use on the great railways of Russia. These projects include the construction of an electric railway to connect neighbouring towns on the western frontier of Russia, and the establishment of a road to cross the Caucasus Mountains between the town of Suhkum and one of the stations of the Vladikavkas Railway. For this latter road it is proposed to utilise the hydraulic force of the mountain streams. Electric traction is already in force on the railways serving large factories in the mining industry, and in other enterprises. Up to the present, electricity has scarcely been used at all for the transmission of energy for great distances. Projects are, however, under way to utilise the waterfalls of Marva and Imatra. The Russian Government has granted a concession to a company to supply power to St. Petersburg from the Volhov rapids. The estimated cost of this enterprise is about £2,800,000. It is also intended to use the colossal force of the Dnieper cataracts for the transmission of energy. The progress of the electro-chemical industry and of electro-metallurgy is interwoven with the utilisation of hydraulic force as motive power. For instance, there are even now several establishments which obtain copper and refine metal by the electrolytic process. Such establishments exist in the Ural and the Caucasus, and have an output that is important. Thus, the works of Siemens Bros. at Kedabeg in the Caucasus annually produce some 500 tons of copper. Many less important works in St. Petersburg, Moscow, Nijni Novgorod, &c., utilise steam power for the refining of copper and impure copper waste by the electrolytic process. Some of these works obtain as by-products of the electrolytic process other metals, such as lead, antimony, &c. There are as yet very few special electro-chemical works in Russia; one factory near the Imatra rapids produces carbide of calcium, and other works for a similar purpose also exist. A large electro-chemical factory has been erected in the Government of Kharkof for the production of caustic soda. It will be seen that the application of electricity has progressed in Russia, and that electro-technical appliances will have a great future in that country. Russian factories cannot supply the demand, and the deficiency is made up by foreign firms which have their representatives in the country. Russian manufacturers produce many cables and insulated conductors, and yet large quantities are imported from abroad, the home manufacturers not being able to supply the market. Measuring and counting instruments are scarcely manufactured at all, although the demand for them is enormous, especially of late, since central stations have been constructed in a number of towns. These instruments are imported from France and Germany. Incandescent lamps are not manufactured in Russia at present, and the lamps are imported from Germany, France, England, Austria, and Sweden. Arc lamps are produced in Russia, but only in limited quantities, and the greater number of those used are imported from Germany. One branch of the electro-technical industry is fully supplied by the home manufacturers, and this is the signalling and telegraphic apparatus in use on the railways. As regards telegraphic appliances proper, some are manufactured in Russia and some come from abroad, chiefly from Sweden and Germany.

*ON THE SUSPENSION OF LIFE AT LOW TEMPERATURES.**

Our first experiments were made with organisms possessing varying degrees of resistance, the extremes in this respect being represented by the sensitive spirillum of *cholera asiatica* and the resistent spores of *bacillus anthracis*. Ten organisms altogether were used and cooled down to —190°C., in the first instance for twenty hours, and eventually for seven days. These exposures did not produce any appreciable impairment in the vitality of the organisms, either as regards their growth or their characteristic physiological properties, such as pigment and gas production, pathogenicity, &c. Amongst the organisms tested were photogenic bacteria, and these likewise preserved their normal luminous properties; and we were able, through the kindness of Professor Dewar, to apply a still severer test—namely, an exposure to the temperature of liquid hydrogen (about — 252°C.), a temperature which is as far removed from that of liquid air as is that of liquid air from the average summer temperature. Ten hours' exposure to this temperature had no appreciable effect on the vitality of the micro-organisms tested. At such temperatures it must be assumed that the chemical metabolism of the cell ceases, in the absence of heat and moisture. At the same time it appeared to us advisable to test the influence of a prolonged exposure to low temperatures on the vitality of cells. The experiments were conducted with the aid of the liquid air plant at the Jenner Institute of Preventive Medicine. The organisms employed were the *B. typhosus*, *B. coli communis*, *Staphylococcus pyogenes aureus*, and a *saccharomysce*. The bacteria were suspended in small loops of platinum wire or on cotton-wool swabs, and directly immersed in the liquid air. The yeast, washed and pressed, was wrapped in rice-paper, and likewise directly immersed in the liquid air. Samples were taken and tested at intervals for a total period of six months. In no instance could any impairment of the vitality of the organisms be detected. The yeast gave a good growth, and exhibited its fermentative powers unaltered; the typhoid bacillus retained its pathogenic and other properties; the *Staphylococcus aureus* gave a characteristic pigment growth; and the *colon* bacillus responded to all the typical tests that were applied to it. Judging by the results, the experiments might have been prolonged for a much longer period than six months without appreciable influence on the vitality of the organisms in question.

The ordinary manifestations of life cease at zero, ut at —190° C. we have every reason to suppose that ntra-cellular metabolism must also cease—as a result of the withdrawal of two of its cardinal physical conlitions—heat and moisture.

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* Abstract of a paper read by Mr. Allan Macfadyen, M.D., and Sydney Rowland, M.A., before Section K, British Association, Belfast.

It is difficult to form a conception of living matter under this new condition, which is neither life nor leath, or to select a term which will accurately describe it.

It is a new and hitherto unobtained state of living matter—a veritable condition of suspended animation.

THE MANUFACTURE OF SAUSAGES IN SPAIN.

Among the oldest and most prominent industries in the district of Barcelona, is the manufacture of sausages. Although the preparation of hams and sausages is also carried on to some extent in the provinces of Asturias, Huelva, and Estremadura, the principal seat of the industry is in the province of Catalonia. The chief centre is the old town of Vich. situated on an elevated plain on the southern slopes of the Pyrenees. The climate and character of the surrounding territory are particularly well adapted to the rearing of pigs, while the large steam-power factories to be found there are a proof of the thriving nature of the trade. According to statistics, the number of pigs slaughtered in Catalonia in 1900 was 114,629. In preparing the meat for the sausages, it is first minced, usually by machinery, though in the farmhouses it is still done by hand, the peasants claiming that when cut in this way the meat retains more of its moisture and flavour. After the pork is minced, and the desired quantity of bacon has been added, the necessary proportion of pepper and salt is thrown in—generally 4 per cent. of salt. The whole is then well mixed, and pressed into a compact mass, which is encased in intestines which have been previously washed clean, all fatty matter having been removed and a small quantity of salt introduced. This operation requires some care in order to insure a vacuum in the cases. The genuine Vich sausages which are famed throughout Spanish-speaking countries, are prepared exclusively from lean pork and a small quantity of bacon without admixture of any other kind of meat. As the sausages are made, they are placed on tables, and wrapped in clean cloths in order to extract any excess of moisture. After a few hours they are hung in the drying room, care being taken that each sausage hangs separately, to get the benefit of the circulation of air. Every precaution is taken to keep out the hot, damp south-east wind, known as the sirocco, the effects of which are most prejudicial to the drying process. The sausages made in the vicinity of Vich are supposed to acquire a special flavour which distinguishes them from those made in other parts. This peculiarity is not due to any preparation, but is apparently gained during the process of drying, as sausages prepared in other districts and brought to the plain of Vich to be dried, acquire the same distinguishing aroma. The estimated annual output of the Vich factories is valued at nearly £200,000.

*THE SMOKELESS COMBUSTION OF BITUMINOUS FUEL.**

The author points out that engineers are taught the conditions necessary to combustion, but they do not practise them, and the modern boiler is fixed in the most primitive manner.

Certain fuels burn without smoke, and may be burned directly below the heat-absorbing surface. This cannot be done smokelessly with hydrocarbons, because of the greater avidity of hydrogen than of carbon for oxygen, and the necessity of preserving a high temperative for burning hydrocarbon gas. The difference between long and short flaming coal is pointed out and the effects noted.

The effect of refractory furnaces is discussed in the paper. The refrigerating effect of volatilising solid hydrocarbons is discussed in its effect on the distribution of temperature in a furnace, and the production of heat at and beyond the grate surface. Though less heat is produced at the grate surface, the total heat-production of bituminous coal is eventually secured if suitable furnace arrangements are provided for the purpose.

The faults of everyday boiler-settings are pointed out in respect of various types of boilers, and the bad effect of cold-water pipes in the path of the furnace gases is referred to. Though so bad as a smoke prodncer, the common form of water-tube boiler can easily be set so as not to produce smoke. The furnaces must be so arranged that all the gaseous products of the furnace are swept together with all the admitted air, and are not cooled down until sufficiently burned to admit of being used. For this purpose furnace linings must be non-heat absorbant. Small-tube boilers are condemned in their more common forms, and the arrangement of the refractory furnace of the Weir boiler pointed out as affording economical and smokeless combustion.

The locomotive is also instanced as an example of how partial recognition of the correct principles has been fairly successful.

Some of the attempts to secure smokeless combustion are discussed, and the conviction expressed that there is nothing in smoke prevention to justify the assertion so often made that it is economically impossible. The final conclusion is that smokeless combustion of bituminous coal is as easy and certain as the reverse method.

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* Abstract of Paper read by W. H. Booth, M.Am.Soc.C.E., before Section G, British Association, Belfast.

TURKISH CHROME.

Chrome is found both in European and Asiatic Turkey in considerable quantities, but only districts within easy reach of the sea have been worked. The principal workings are in the neighbourhood of Salonica, Broussa, and Macri. The largest deposits are said to be in the district of Denislie, but the Government have granted no permits to work this region. The Denislie ore has yielded in tests as high as 56 per cent. of oxide of chrome, and is a surface deposit. This district has recently been discovered, and is supposed to be a continuation of the Macri chrome stratification. The deposits are some distance from the railway, and the cost of transport to Chardak, the nearest station on the Smyrna-Ottoman Railway, is high. The Broussa mines are comparatively new, and most of this output has gone to the United States. The proprietor of the Broussa mines is Ragoub Bey, a functionary in the Sultan's palace, and, according to the United States Consul at Smyrna, he has an advantage over his competitors, as he pays no royalty, the mines having been presented to him by the Sultan. The Government collects a mining royalty of 20 per cent. on chrome, and a customs duty of 1 per cent. The transportation is usually done by camels. Chrome is found in pockets of variable quantities, scattered indiscriminately over Asia Minor, but the great majority remain unworked owing to lack of roads, and other difficulties in the way of transport. The ore is frequently mixed with gang rock (serpentine), and only of late years have any experiments been made looking to the separation of the chrome from the refuse. In the Macri district owing to winter rains, the work is carried on only in spring, summer, and autumn. Native labour is employed, which costs about nine pence per day. During the last two years, no new mining concessions have been granted, and for the present the Turkish Government only issues shipping permits for 2,000 tons for any new mine, and when this permit has been exhausted a new one must be obtained before the work can be continued. There is a tendency on the part of the Government to prevent mining properties from passing into the hands of foreigners. The actual title of any mine in Turkey must rest in the name of a Turkish subject.

Correspondence.

PAINTING OF BUILDINGS IN MANCHESTER.

Anyone visiting Manchester at intervals will observe the growth of the blackening of the large buildings, both in extent and in depth of tint, due to the soot and slush of the local atmosphere becoming increasingly deposited thereon for many years. The restoration of a more natural coloration by painting the walls does not seem to be taken up by proprietors and owners here, as is done in London and in cities abroad. The "Queen's," the "Albion," and the "White Bear" seem to be the few instances of painting the exteriors, which have so far not been copied by other hotels, warehouses, or offices, much as it would enhance their present gloomy aspect. In the meantime it might be suggested that their sombreness might be artistically relieved by painting only the sills and mullions of the windows and the jambs and lintels of the hall doors. This might be done on the side facing the street very effectually in such colours as the owners would prefer themselves to beautify their edifices, thus making the streets more picturesque. This painting of the margins of the windows and doors might be arranged collectively in special colours, so as to represent special types and uses of individual edifices. Public buildings, for instance, might select red for coloration, stores and warehouses might choose brown for windows and doors, and hotels and inns have their painting done in yellow. Thus some artistic modification of colour might be adopted to relieve the funereal sombreness of the streets and make them wear a more cheerful appearance to the residents strolling through them and to the traveller on his visiting the city.

W. T. Black
(Memb.Soc.Arts, London.)

General Notes.

German Pumice Stone Bricks.—According to a recent German report, there is in the Neuwied district along the Rhine, between Coblenz and Andernach, an extensive industry in the manufacture of bricks from volcanic sand and pumice stone, which are found along the base of the Eifelberg. In working the deposits, the surface soil is stripped off, and the sand is piled up, to be shovelled into the mixing bed of water and lime close at hand. The pumice comes out of the earth in pieces varying in size from grains to lumps some four inches across. It occurs in layers, but is frequently interrupted by small patches of more solid fragments of lava. Before moulding, the pumice is screened, larger pieces being broken to pass through a sieve with half-inch meshes. These screened pieces are then covered with a thin coating of cement, and the brick is moulded. The cement is not mixed with the pumice so as to form solid cement blocks, but by the fragments being coated first. The brick is then obtained by these coatings adhering to one another. In the manufacture of 20,000 bricks about 4½ tons of lime are required. After the mixing process, the substance is poured into iron moulds provided with bottoms of detachable boards, which, after the removal of the moulds, act as driers. When the bricks have been exposed to the air for a very short time they are ready for shipment. No modern machinery is used. A workman makes from 800 to 1,800 bricks a day.

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Notices.

VIVA VOCE EXAMINATIONS.

The following reports on the results of the *Vivâ Voce* examinations held last Session have kindly been furnished by the Examiners. The total number of candidates examined was 280 —186 French, 54 German, and 40 Spanish.

French.

In several institutions it was evident that the instruction in colloquial French had been carried out on satisfactory lines. A fair proportion of the candidates could converse fluently and sensibly on topics of general interest, and a considerable number showed that they possessed tolerable facility in expressing themselves. On the whole, the exercises in dictation were highly creditable, and some were practically faultless. Weakness in this part of the work caused the rejection of a few candidates. Whilst the reading of a French passage was generally satisfactory, there were rather too many instances of defective pronunciation. In every centre there were clear indications of commendable enthusiasm and interest on the part of the students. The general results were distinctly good, and this examination should have a powerful influence in encouraging the teaching of living languages in this country on a rational and practical system.

Ernest L. Naftel,

One of the Modern Language Examiners to the Oxford and Cambridge Joint Board; the Delegacy of the University of Oxford, and the Syndicate of the University of Cambridge; late Examiner in French to the Central Welsh Intermediate Education Board, &c.

German.

During the summer of the present year, 1902, I conducted, at three different centres, *Vivâ Voce* Examinations in German, in accordance with the scheme put in practice this year by the Society of Arts for the first time.

The results were, on the whole, extremely satisfactory, and a good percentage of the candidates reached the standard of practical efficiency determined upon.

On the other hand, there were a number of cases in which candidates were obviously not prepared to meet the demands of such a practical test, and felt so themselves at the critical moment. Such candidates, I believe, will have profited not least, by gaining a better understanding of the nature of such an examination, and an incentive to future effort.

Even in many cases where the standard of the examination was not reached, I discovered signs of much good work and sound teaching, and, on the whole, found the results of this first experiment most encouraging.

H. G. Atkins,

Professor of German, King's College, London.

Spanish.

I am pleased to be able to report very favourably on the results of the *Vivâ Voce* Examinations. The great majority of the candidates possessed a sufficiently copious vocabulary to express themselves fluently, and understood correctly the various idiomatic expressions that were put to them. Their pronunciation was very good. The result on the whole is very satisfactory.

Ricardo Ramirez.

MALAY BOATS AND BOAT BUILDING.

Mr. Walter W. Skeat has communicated the following supplementary notes to Mr. Warington Smyth's paper on "Boats and Boat Building in the Malay Peninsula," which was read on May 14, 1902 (see *ante*, p. 569). The following notes refer to some additional illustrations of these boats:—

Fig. 1 is taken from the photograph of a model "kolek," or Malay sea-canoe, now in the Cambridge Museum. This particular type is that of the "kolek" as it is known on the Selangor (*i.e.*, west) coast of the Malay Peninsula. It obviously differs in several respects from the racing canoe (also called "kolek") of Singapore, and somewhat curiously approaches, in fact, in build and general appearance, the "cheemaun," or birch-bark canoe of Canada. The curious cylindical "bit" which is lashed in position across the stem of this type of sea-canoe ("kolek"), and furnished with what are called "crab's eyes" (mata ketam) in Malay, is worth noting. It is probably the highly conventionalised form of some more or

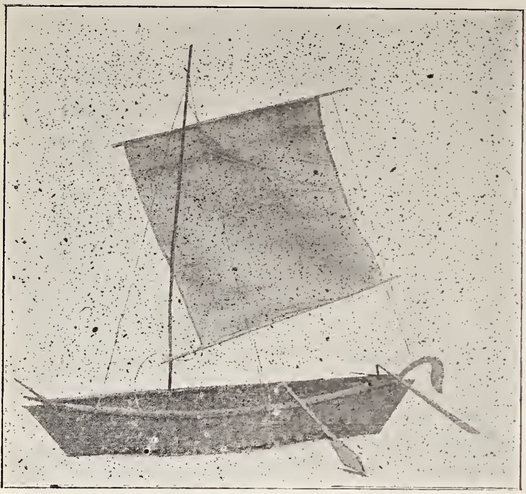

Fig. 1.—Malay "Kolek" or Sea-canoe—Selangor or West-coast Type.

less typical bow furniture, the fisherman's line being allowed to hang overboard between the "eyes," which then help to keep it in position. This boat is always steered by a paddle.

Fig. 2 represents the "Poonggei," a "kolek," or Malay sea-canoe (Singapore racing type), the property of one of the local rajas, reproduced by the kind permission of the editor of the *Yachtsman*. It will be seen that the criticism of its build, &c., made by Mr. Warington Smyth in his paper are fully borne out.

Nevertheless, it is this type of Malay boat of whose speed so many remarkable stories have been told, and which has earned for the Malays the very high reputation for seamanship which, among native (non-Europeanised) races, they undoubtedly possess. The truth seems to be that these craft are, beyond any doubt, exceedingly slippy, and can show a very clean pair of heels when running more or less *before the wind*, but are of quite inferior speed under any other circumstances. A centre-board would, no doubt, as Mr. Warington Smyth suggests, improve them immensely.

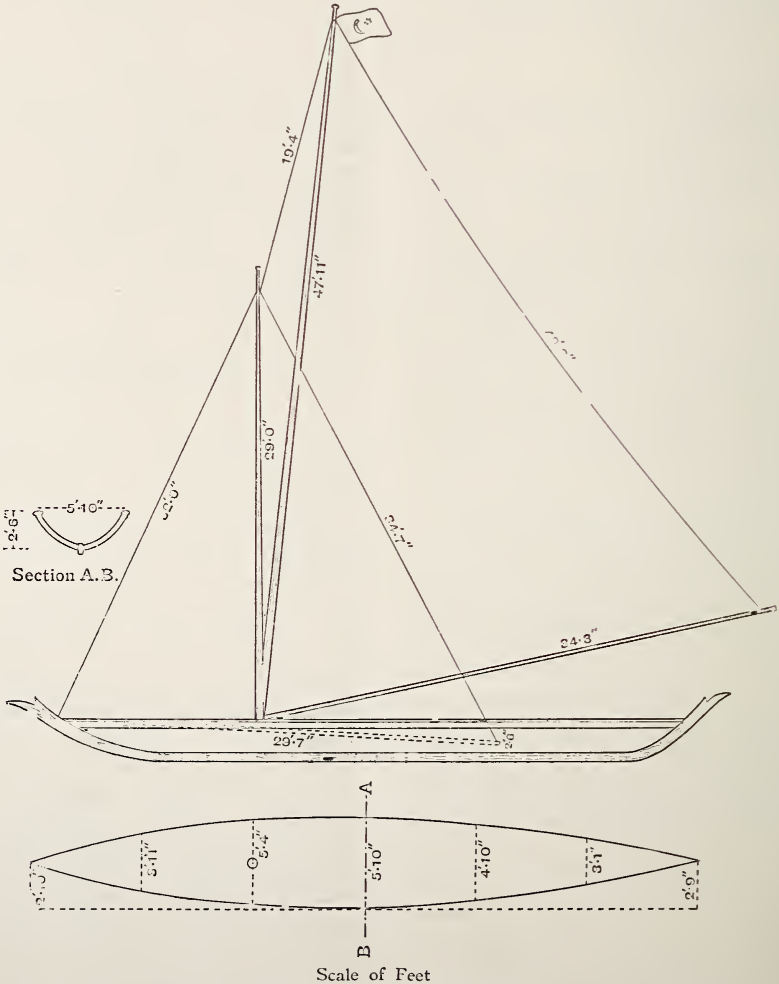

Fig. 2.—Malay "Kolek" or Sea-canoe—Singapore Racing Type.

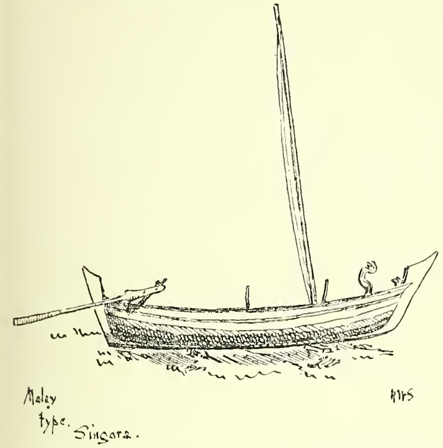

FIG. 3.—MALAY "KOLEK" OR SEA-CANOE—EAST-COAST TYPE.

The "kolek" of the east coast (Kelantan and Patani is a third (and a very different type), not unlike a small "payang."

The following is the translation of a valuable explanatory note received from a Malay correspondent since the publication of Mr. Smyth's paper, the note being accompanied by the subjoined diagrams, the first of which, (*a*), represents the "layer sabang," or "sprit-sail," set up by its "spreet" (as Mr. W. Smyth surmised); the second (*b*), being the sail called "layer gusi," or "fore-and-aft gaff sail," and the third (*c*), representing the "gusi" sail with "gaff top-sail" ("gap tap-sir") in addition. (See p. 578, col. 1, *ad med.*; and also p. 579, col. 1, *ad fin.*)

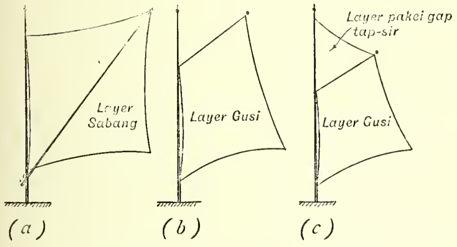

FIG. 4.—THREE TYPES OF SAIL—

(*a*) Sprit-sail, set up by its spreet.
(*b*) Fore-and-aft gaff-sail.
(*c*) Ditto, with top-sail in addition.

The text of the note continues as follows:—

"The Payang formerly carried 40 men, but this was when it was used for piratical purposes, and that was why it carried so large a crew.

"At the present day it carries one master (juragan), one boatswain (Jerbatu, lit. 'master of the anchor'), one helmsman (jermudi), ten seamen (klasi), and a cook (tukang masak), in all about 15 men—*a crew of 40 would mean a pirate.*

"The Gurap ('Grab') is certainly as much as 300 feet long, *i.e.*, as big as a small 'Fire boat' (or 'steamer!')

s.v., "Tolak bara," the word "*t*alas" should be "*b*alas (= Eng. 'ballast')."

"The Salah-salah is quite as much as 200 feet long, in some cases it is as long as the Gurap."

To the foregoing may perhaps be added the names of some of the Malay boats of the Peninsula which were not included in the paper. Among these are:—

1. Prahu Kepala Belalang, or "'Mantis-head' boat."

This boat is described by Clifford and Swettenham as a long, narrow boat, the deck of which is below water-level, with plank sides, and awning or "kajang" of "atap" (palm leaves). It is said to be much used in Kelantan, on the east coast of the Peninsula.

The name of this boat was doubtless given on account of its rounded figure-head, which is not unlike the head of the insect referred to.

To the list of canoes should be added the "prahu sagor," which is a kind of "dug-out."

A few corrections of the original paper are also here given. It should be explained that the first list of boat measurements was collected for me by Malay friends at Klaang in Selangor, the second list by Mr. C. Curtis of Penang. In both cases my sincere thanks are due for what was doubtless a tiresome job. Page 579 (first illustration), "ketiap pengallak" should be "ketiap penggalah," *i.e.*, "poling house-boat" (for description, *see* page 581). *ib.* col. 1, last line but three, the words "sprit-sail set up by its sprit (*sic*)," should read "sprit-sail, set up by its *spreet.*"

Page 583. In consequence of pressure of time the present writer was unable to revise the second Table of Boat Measurements, and hence in many cases the Malay equivalents for the various measurements were retained instead of the English ones. The following are the English equivalents:—

Mal. "Depa" = Eng. "fathom" (6 ft.).
Mal. "Kaki" = Eng. "foot" (12 in.).
Mal. "Pikul" = $133\frac{1}{3}$ lb. av.
Mal. "Koyan" = 40 pikul = $5{,}333\frac{1}{3}$ lb. av.

[N.B. These measures are abbreviated in Mr. Smyth's paper to "pik." and "koy." respectively.]

There are also a few mistakes in the names of boats given in this section, thus:—

"*G*alor" should be "*j*alor."

"B*a*dar" should be "b*e*dar."

"L*a*bak bergantong" should be "l*e*bak bergantong."

"Lanchara lanchara" should be "lanchara" (once only).

There are also two or three slight slips in the glossary:—

s.v., "Buah berembang" the words "In Jav. Berembang *v.* onion" should read "In Javanese 'berembang' = 'onion.'"

s.v., Linggi (stem-piece), add "also called 'Tangkup.'"

s.v., "Papan lupi," the word "lup*i*" should be written "lupi*k*" or "lup*i*'."

s.v., "Pengayu*k*," the word should be "pengayu*h.*

THE FUTURE OF THE TELEPHONE IN THE UNITED KINGDOM.[*]

To the members of the British Association the telephone and its applications cannot fail to be of interest, for they must ever recall with pride that it was at the Glasgow meeting of the Association in 1876 that Alexander Graham Bell's invention was first introduced into this country by the Sir William Thomson of that time, and the Lord Kelvin of this. The telephone then was a scientific marvel, and attention was centred on its improvement as a talking instrument. Some of its possibilities were foreshadowed, but its principal application was not foreseen. At the meeting of the Association at Sheffield in 1879 an exchange was shown in operation, coincident with the opening in London of public telephone exchanges. From that time the science of the telephone has been the science of telephonic intercommunication.

Like all the more recent practical applications of scientific principles, it is in itself a composite art, calling to its aid not only acoustics and electricity, but of late years more particularly, the heavier branches of mechanics and engineering, since the modern telephone exchange has anticipated the power schemes by producing at one centre the electrical energy required to signal and to talk between thousands of stations over lines mostly placed underground at a considerable cost, and requiring much engineering skill. Any one of the elements of this composite art would afford interesting subjects for discussion. But they have been and will be dealt with elsewhere and at other times, and will be only very casually touched upon in this paper. The future progress of the telephone in the United Kingdom does not depend upon scientific developments, but upon common sense. In this it does not differ from most engineering questions, for I take it that engineering is a means to an end; that an engineer would derive little satisfaction from the construction of a bridge, however beautiful its proportions, if the approaches rendered it of no utility.

There are at the present time some impediments on the approaches which need removal. They are of a political, economical, and social nature, and they exist, as I think, largely on account of the lack of public recognition of the peculiarities which differentiate a telephone exchange system from other works of practical utility. It is my object in this paper to attempt to remove some of the popular misunderstandings which undoubtedly exist, and by placing before you some of the features upon which telephone service depends, draw some conclusions as to its future. You will, of course, be prepared for a considerable dip into the past and some reference to the present before the future is reached.

It is necessary to bear in mind that in 1870 various companies undertaking the transmission of telegrams were acquired by the State, and the work which they undertook was combined with that of the Post Office. The Act of 1869 extinguished competition in telegraphs, and conferred on the Postmaster-General the exclusive privilege of transmitting telegrams. The Post Office had been carrying on this business for six years when the telephone was invented. Its development and application to purposes of profit in the United Kingdom took another three years, so that telephone exchange companies began operations in London in 1879. The Post Office claimed that the service rendered by the telephone companies was an infringement of the powers conferred on the State by the Telegraph Act of 1869. The telephone companies contested this claim, but it was decided in favour of the Post Office in the suit of the Attorney-General *v.* The Edison Telephone Company of London, Limited, tried before Mr. Baron Pollock and Mr. Justice Stephen in 1880.

The reasonableness of the decision is even now sometimes questioned, mainly because the Act was passed in 1869, and the telephone invented only in 1876. But distinction needs to be drawn between (1) a service which the State reserved to itself the sole right of undertaking; and (2) improvements in apparatus for, or in the means of carrying out, that service.

The service reserved by the State was the transmission of telegrams, and in Mr. Justice Stephens' very careful judgment he shows that within the definition of the Act of 1869, "Any apparatus for transmitting messages by electric signals is a telegraph, whether a wire is used or not, and that any apparatus of which a wire used for telegraphic communication is an essential part is a telegraph, whether the communication is made by electricity or not." Thus the telephone was only an improvement in, or an accessory to, the service of which the State held a monopoly.

Counsel for the company gave notice of appeal, and the Attorney-General, on behalf of the Crown, stated "That, of course, the Postmaster-General is fully alive to the advantages derived by the public from telephonic communication, and whatever result this litigation may lead to, care will be taken in the interests of the revenue, and also in the interest of the public, that nothing shall be done to stop telephonic communication so far as it is required by the public." This statement foreshadowed the policy which the Government had considered it advisable to pursue, viz., to work telephone exchanges through the medium of private organisations or public companies acting under license. Licenses were issued for a period of 31 years, conditional on payment of 10 per cent. of the gross receipts. An indication of the Government's intention to resume the working of the system at some period is given by a condition of the license that the Government were to have the right to purchase the licensee's business at septennial periods upon giving six months' notice, and subject to arbitration in event of disagreement on price.

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[*] Paper read by J. E. Kingsbury, before Section G, British Association, Belfast.

The first licenses limited communication to four or five miles from a defined centre, the State providing trunk lines between the areas. The limitation was found to be inconvenient. It was removed in 1884, and trunk wires between towns were erected by the companies. In 1896 the trunk wires were purchased by the Post Office, and the companies work limited to "telephone areas" based on the requirements of localities.

Efforts have been made to obtain a reduction in the Post Office royalty, which has been denounced at various times, and has been complained of as a tax on communication, as the newspaper stamp was denounced as a tax on knowledge. But even the sufferers by it did not universally condemn that objectionable tax, for Addison, in the *Spectator* of the day preceding the application of the stamp, intimated that he would glory in contributing his utmost to the public weal, and remarked that "It is a received maxim that no honest man should enrich himself by methods that are prejudicial to the community in which he lives, and by the same rule I think we may pronounce the person to deserve well of his countrymen whose labours bring more into the public coffers than into his own pocket." In this mildly ironical way did Addison convey the information that of the price paid by the purchaser one-half went into the public coffers. The telephone royalty is more moderate, and it cannot be said that the labours of the Telephone Company put more into the Treasury than is distributed amongst their shareholders, but the amount is a substantial one, for during the last ten years the company has paid in Post Office royalty £916,000 in round figures. For the past year the royalty was about £150,000. The royalty is a part of that protection of the revenues of the State to which the Attorney-General referred, and so far as the companies are concerned, it may be regarded as a payment by means of which they are enabled to earn dividends, since, without a license, it would not be possible for them to undertake the business at all.

The Post Office not only reserved the right to compete, but in some places actually did compete, and in others granted licenses freely to competing companies. The inference to be drawn from their attitude is, that they were careful not to create a monopoly outside themselves, regarded freedom of action as tending to the public benefit, and were satisfied to let ordinary laws work out the solution of the problem so long as their sovereign rights were maintained and their tribute paid. The service was a new one, there had been no previous experience of its working and no reasonable forecast could be made.

The competition which existed between the Bell Company and the Edison Company in 1879 ended by the amalgamation of the two into the United Telephone Company in 1880 before any considerable work had been done; and resulted rather from the advantage of combining patent rights than extinguishing any extensive business competition. But as a subscriber to the Edison Company, I am able to bear witness to the advantage of the increased capacity of communication which resulted from the amalgamation, small as that would seem now. Shortly after the amalgamation a company called the London and Globe Telephone Company established an exchange in London, proposing to charge a reduced rental of £12 per annum, instead of £20, the rate then ruling. The company discontinued its operations after a few hundred subscribers had been connected, because it was unable to obtain instruments free of the Edison patent. As a subscriber to the London and Globe Company, I can also speak from experience of the advantage of the reduction in telephone subscriptions which resulted from the cessation of a duplicate service. The other principal competitive exchanges during the patent era were at Dundee and Sheffield, and in anticipation of the expiry of the patents, an exchange was started in Manchester by the Mutual Company.

The Dundee Company was purchased by the National Telephone Company at an early stage in its career; the Sheffield Company was eventually absorbed, and the Mutual Company lived but a comparatively short period.

The popular view of these amalgamations is well known. The real reason has been overlooked. Before formulating it. I will ask you to consider what a telephonic conversation is, and how it is obtained?

Let me make a comparison between telephone exchange service with which we have been familiar for a little more than 20 years and other services which have existed for much longer periods.

There are no longer any competing telegraphs in England, but let us suppose there are. I desire to send a telegram to any town. I can take my choice of lines. There is no restriction whatever on the delivery of my message to any inhabitant of that town I may desire to communicate with. In the same way I may take advantage of railway competition by choosing the cheapest or quickest route, or I may prefer to take the longest or most expensive route on account of its natural beauties. What would be thought of the advantages of a railway competition from London to Liverpool if the latter city were divided into two portions, and it were ordained that for a destination on one side of St. George's-hall it would be necessary to travel by the North-Western, and for a destination on the other side by the Midland Railway. Let us suppose the issue of season tickets. With one season ticket a passenger would be able to reach one-half of Liverpool. If he desired to reach the other half as well he would require two season tickets, and would need to take a different route for either destination. By the division I do not mean a policeman outside the station to direct your cabman by a given street which order he can evade at the next turning. You must please to imagine an impenetrable barrier. You regard this undoubtedly as a preposterous proposition, but it is exactly analogous to the conditions prevailing under competition in telephony. There are a restricted number of possible correspondents for distinct services or double season tickets if you wish to enlarge your area of communication to the fullest possible extent.

The reason why competing services have ceased in the past, is because the absurdity of such a situation becomes obvious when put in practice.

Let us see how the subscribers of the lapsed companies fared in the combinations which have been made. The Dundee Company, at the time of the amalgamation, had 332 subscribers; 125 of these subscribers belonged to both companies, and thus had two season tickets. Each subscriber to the local company paid £5 10s. per annum. He thus paid 3·975d. per annum each for the opportunity of communicating with 332 subscribers. On amalgamation the subscriptions of the 152 were slightly reduced, and of the 180 largely increased, but the annual cost of the right to speak with each other subscriber was reduced from 3·975d. to 2·919d., and with the increase in subscribers this reduction was continually growing in favour of the original subscribers. In addition to the larger number of possible correspondents in their own locality, the amalgamation gave the subscribers to the local company access to other localities, thus adding considerably to the value of the telephone to them. The influence of a widespread "telephone net"—to adopt a Continental expression—may be compared with the force of gravity. Sooner or later the smaller local body if it do not evaporate altogether must be attracted to the larger body. And if the repellent force natural to competitors should retard unduly the operation of this attractive force, then the latter will inevitably be assisted by some superior power in the interest of the public weal, for it must be remembered that the proprietors of exchanges and the subscribers thereto are not the only people concerned. The general public experience some of the drawbacks of this competition. As an example, I may cite an instance from Scandinavia—a part of the world frequently referred to in connection with the advantages of competition in telephony. About the time of the competitive services in Dundee, rival companies were giving the citizens of Christiania the same advantages, when (August 20th, 1884), "The Municipal Council resolved, in accordance with the proposal of the Executive Committee, to notify the International Bell Telephone Company, and the Christiania Telephone Association, that after two weeks they shall not be allowed to run new telephone lines over the public streets, squares, &c., and the Council appointed Messrs. Birch, Reichenwald, Anderson, and Christopherson to aid the Executive Committee in negotiating with the telephone companies an amalgamation into a single company." The round table conference succeeded in its efforts, the competition ceased, the number of subscribers grew rapidly, and the exchange has since been acquired by the Government.

The experience of Dundee was not repeated in the United Kingdom for a number of years, because the National Telephone Company were protected by patent rights. On the expiry of the patents, a number of public-spirited citizens of Manchester combined to remove from their town the stigma of being dependent on a telephonic monopoly, and to demonstrate to their predecessors of Dundee the iniquity of being bought up at a profit. They formed the Mutual Telephone Company, of Manchester.

The Mutual Company was in due course acquired by the National Company. At the time of the amalgamation, 492 of the 1,349 subscribers of the Mutual Company also subscribed to the other company. The ratio of subscription to number of subscribers, that is, the cost of the opportunity to communicate was 1·320d. per subscriber per annum. On amalgamation it was reduced to ·567d.

In the Parliamentary Committee Report of 1895 it is shown that the average payments of the Mutual subscribers were £7 8s. 6d. per annum. The average rate of the other company is not given. The normal rate was £10. The average would probably be slightly higher. The total payments by the people of Manchester before and after amalgamation were approximately as follows:—

Before amalgamation:—						
National	3,374	at £10	0	0	£33,740
Mutual	1,349	at 7	8	6	10,016
	4,7 3				£43,756
After amalgamation:—					
Combined subscribers	4 723				
Less duplicates	492				
	4 231	at £10	0	0	£42,310

Whilst the latter total is lower, yet in the absence of definite information as to the National Company's average the figures must not be taken as more than an indication that, to the then existing subscribers, there was no very material change in the total cost of the service.

But this, even if admitted, does not go far with the advocates of competition. The contention is, that the lower rate was a paying one, and that all subsequent subscribers have been overcharged by reason of the absence of competition.

The claim that the lower rate was a paying rate is based on the assertion that, during the existence of the competing companies, they were able to make both ends meet. I neither confirm nor combat the assertion, but I wish to correct an impression which is very natural to the mercantile mind. It is that on the fixed subscription plan every additional subscriber is a monetary gain.

A new subscriber adds to the working expenses, in that he not only makes calls himself, but increases the calls of other subscribers. With the growth of the exchange there is an increase in the apparatus or plant used in common, such as junction wires and switchboards, as well as in the number of operators.

Hence, with the same class of equipment, the increase in subscribers leads to a disproportionate increase in cost of plant and working expenses.

The reason why the working costs at the present time are not considerably higher than in earlier years is, because the class of equipment is not the same. Improved appliances have been introduced, additional plant has been erected or old plant re-organised, enabling the work to be done more economically.

But these improvements have cost money, and it will at once be seen that upon these early exchanges, which are so often referred to, further expenditure would need to have been made without an increase in revenue, and from this may be seen the importance of making an allowance for depreciation before arriving at the cost of the service. Depreciation in telephone plant must not be confounded simply with the wear and tear of ordinary machinery. Certain portions may be claimed to be practically indestructible in themselves, and yet require considerable depreciation allowance. This arises from the changes caused by growth, whereby plant is displaced even though capable of continued use. No rule can be laid down for universal application. There are instances of 5 per cent. and of 15 per cent. being allowed, but the medium figure is more general.

As I have said, the real lesson of the amalgamation was never learned. The apparently profitable nature of telephone enterprise, the invariable maintenance of the rates at the higher level, conveyed an impression which has been sedulously fostered that the absorbing telephone companies were simply seeking, in Addison's words, "to enrich themselves by methods that were prejudicial to the community," and Parliament determined by the Act of 1899 to develop, by the aid of the ratepayers, that competition which had so far failed under private enterprise.

Two municipalities, Glasgow and Tunbridge Wells, have taken advantage of the permission, and history is repeating itself in its usual way.

The first annual report of the Telephone Committee of the Glasgow Corporation shows that £192,693 14s. 3d. has been spent in equipping an an exchange for 5,494 stations. "The stations are subscribed for by 4,697 persons and firms; of these, 2,059 have never been telephone subscribers before." This may be taken to mean that all the other subscribers to the municipal exchange are also subscribers to the company's exchange. The average capital expenditure per person or firm (not per station) is £41, but the total expenditure includes work which is very properly undertaken in advance of requirements, and it is a reasonable inference that with a comparatively small additional expenditure sufficient subscribers could be added to reduce materially the above average. It is futile to take only the cost of the useable lines, because there always will be considerable excess. I want only to make a comparison between the useful and the useless expenditure. At a capital outlay of £35 each, 2,059 new subscribers give a useful expenditure of £72,065, and 2,638 a useless expenditure of £92,330. It is not necessary for me to suggest how very much more useful that useful expenditure would have been if it had widened the field of the new subscribers.

In Tunbridge Wells the same results of duplicate subscribers and duplicate subscriptions are found, as was inevitable.

The necessity of anticipating demand, and the supply of plant largely in excess of that actually used, is inherent in telephone service. Conduits in anticipation of cables, cable in anticipation of subscribers, switchboard equipment in excess of immediate requirements; all these necessarily exist in any well-planned exchange.

Every subscriber must bear his proportion of the excess, since, of the revenue obtained from the subscribers, a portion must be devoted to interest on capital. Duplicate the system, and, if they are equally well planned, you double the surplus plant, the capital expenditure therefor, and the subscribers' burden thereon.

Compare the action of these municipalities with the admirable arrangement concluded by the Postmaster-General in London, where every subscriber to the Post Office system is in communication with all the 40,000 subscribers to the previously existing system, so that duplicates are unnecessary and no expenditure is wasted Competition is a check—a means of preventing undue profit being made by the producer of a commodity or the supplier of a service, and the maintenance of the check requires the continuance of the competition. Technical advocates of competitive telephony realise its temporary character, as will be seen from the published report of the Glasgow engineer recommending another English municipality to undertake competitive service. Dealing with the question of intercommunication between the rival exchanges, he says, "Intercommunication locally from the beginning would render the development of the Corporation exchange difficult. . . . . But when the Corporation's exchange has become larger the conditions will be reversed. . . . . On reaching that point, intercommunication might be insisted upon by the Corporation with every advantage, for the effect would be to complete the ruin of the opposition system."

It might be argued that it is not the province of a municipality "to complete the ruin" of an enterprise rendering a useful service to any of its ratepayers. It might be suggested that the attempt to destroy sometimes results in being destroyed, but I prefer rather to approach the consideration of municipal telephones in a spirit of sympathy with the municipal ideal, and a realisation of the advantages which may sometimes be obtained by collective effort. It is not surprising that, in the absence of an accurate conception of the nature of telephone exchange work, a municipality should be regarded as a suitable body to undertake it. The first idea that occurs to one is that the municipality is the local authority, and yet as applied to a telephone area a municipality is only one of several authorities, for whilst the business centres throughout the kingdom have grown, the municipalities remain to a very large extent simply extensions of the old parochial system, and the extensions have not been carried far enough. The telephone area is the whole district over which the business and social relations of the locality naturally flows, but in its flow it covers numerous ownerships There is no rivalry equal to the rivalry of neighbouring municipalities; there is not a common interest, and in the absence of identical interests, there is difficulty in obtaining agreement in policy or on the details of carrying out a policy.

Agreement may sometimes be obtained as the result of an enthusiasm against what is regarded, rightly or wrongly, as a common foe; it may be continued while the contest lasts. Assume that "the ruin of the opposition" is completed, will the cohesion continue? Localities change their condition. The fashionable quarter to-day is the business quarter to-morrow. It is the interest of the outlying district to develop its resources. It is the interest of the older and larger municipality—the predominant partner in the telephone area—to retain its prestige, to prevent the development of its rivals. The telephone will be an important factor in such rivalries. Unless it be in independent hands it is easy to foresee a splitting up into smaller units, adding to the confusion, increasing the cost, and generally working to the detriment of the service.

The successful supply of electric light, for example, by municipalities must not be regarded as any criterion of a similar result in the case of telephone exchanges. An electric light station contains a producing plant, the streets carry distributing mains, the service is from the centre outwards, and the entire plant from centre to extremities is under one control. A policy may be initiated and enforced without regard to outside considerations. Telephone exchange service, on the other hand, requires that the system should work in with other systems.

Traffic between two places calls for provision for outgoing calls at one exchange and provision for incoming calls at another exchange. Independent views at either exchange are incompatible with successful working. Neighbouring municipalities running tramway services might so arrange that there could be no through communication, but the inconvenience occasioned to the passenger would be only that of stepping out of one car into another. The equivalent in telephone service would be the stoppage of communication altogether.

One of the arguments urged for local control is that a large percentage of conversations are local. But compare the value of a local conversation with a long-distance conversation, and it will be seen how important it is that no impediment, either of an engineering or administrative nature, should be placed in the way of such communications. Experience shows an almost inevitable tendency to local or individual preferences, both in the way of engineering and management; and experience shows also not only the practical difficulties arising from such preferences, but also the greater difficulty of applying a remedy.

It is sometimes assumed that competition is necessary in order to increase the number of subscribers; I will give an example of phenomenal increase without competition. On January 1st, 1894, there were about 10,000 stations in New York. On January 1st, 1902, there were 72,189 stations in only a portion of the area which was included in the 1894 figures. This considerable increase over the previous progress is attributed to the adoption of a rational system of charging. Up to 1894 there was a "flat rate," the same subscription for large user and small user. In 1894 the message rate system was applied, with the result that the telephone service has become available to the small user, and enormously increased in value to all subscribers by widening the field of communication. This method has also been adopted for the Post Office system in London. It was proposed for adoption some years ago by the National Company, in Sheffield, but the subscribers rebelled against it.

I have remarked on the extent to which the future has to be anticipated by present expenditure. Each new subscriber involves capital outlay, and new present work invariably includes some margin for future use.

The amounts expended during the past five years in adding to the exchange construction and equipment of existing services by similar organisations in the United Kingdom and the United States compare as follows:—

	National Telephone Company.	Licensees of American Bell Telephone Company.
	£	£
1897 ..	460,937	973,063
1898 ..	682,506	1,489,499
1899 ..	742,151	3,189,892
1900 ..	834,772	4,382,908
1901 ..	536,793	4,400,000
	3,257,159	14,435,362

In making these comparisons, I wish rather to draw attention to the yearly growth than to compare the totals. In the United States there is considerable growth in new expenditure from year to year. In the United Kingdom there is a fairly gradual increase to 1900, and a decrease for 1901. The difference suggests some reason.

I think it will be found in the fact that in the United States the companies supplying the service have no limit to their existence. In the United Kingdom the company supplying the service dies in 1911, or, to put it more accurately, its right to continue the business dies then. To the Parliamentary Committee of 1898, Mr. Forbes stated that it would be the policy of the company not to embark on new expenditure after 1904, but to maintain their existing system in the best condition till the expiry of the license in 1911. By the Telegraph Act of 1899 it is provided that the license of the National Company shall be extended in those areas in which competitive services are started, the restrictive barrier against intercommunication being gradually broken down. With longer life the hesitation to undertake further expenditure disappears, for the longer period in which returns may be obtained warrants new investment by the company.

Corporations can borrow easily and cheaply. We thus have financially a most anomalous situation. Money can be spent on competitive systems, which are the most wasteful, which give the maximum of inconvenience with the minimum of public benefit, but money cannot be spent on developing the existing system to which additions can be made at a minimum of cost with a maximum of benefit. The future of the telephone depends very much on the present, for equipment for present subscribers includes some provision for future subscribers, and present starvation means future weakness.

The engineering and construction work should be on a scale that provides for considerable growth, and of a kind that will give reasonable expectation of satisfactory results when that growth is attained. On sound financial principles work on such a scale cannot be undertaken on the terms of existing licenses. The best that could be expected with a sole tenant is a reasonable surplus on present requirements. The best that can be expected from competitive services with unremunerative rates and short tenure is hand-to-mouth construction work and speedy dilapidations.

The existence of duplicate services designed and operated without regard to one another necessarily means that on the expiry of the licenses it may be found better and cheaper for the State to lay down a new system than to attempt to combine the existing ones. I regard it, however, as extremely doubtful whether competitive systems will continue to the end of the license. It seems to me that the result of the competitions now in progress may be easily foretold. I venture the suggestion that competition by municipalities was provided for under a misapprehension of the nature of telephone exchange service, and a misconception of the results, direct or indirect, which might be expected. I venture further the suggestion that those municipalities which have undertaken such competition have done so under a mistaken view of the benefits to be obtained and the cost of obtaining them. But I have too great a faith in public opinion to doubt that as the lessons are brought home the result of existing competition will be the same as previous competitions. Duality will give way to unity as the only reasonable method of conducting the work. Unfortunately the disadvantages must be apparent and realised before they are regarded, and probably much expenditure will be incurred before the mistake is recognised. In the meantime the future progress in the practical use of the most beautiful and most useful application of science which the past century produced will be seriously impeded.

The "removal of any disadvantages of a public kind which impedes the progress of science," is one of the objects of the British Association. The impediment is so much of a public kind as to be fraught with peculiar difficulties, and to involve important considerations of imperial and local politics which are out of our province. I can only hope that the subject may be considered solely from the point of view of the "public weal," and that scientific inquiry may have some share in reaching conclusions. If that be the case, I do not hesitate to express my own belief that the future of the telephone in the United Kingdom will be free from competition, free from the expense and waste of war, developed by the certainty of permanent utility, and cheapened by the economy which unity of control and permanent work will attain.

IRRIGATION IN SOUTH AFRICA.

Mr. W. Willcocks, C.M.G., Managing Director of the Daira Sana Company, Egypt, was directed by Lord Milner, G.C.B., High Commissioner for South Africa, to proceed to South Africa in order to examine the irrigation possibilities of Cape Colony, the Orange River Colony, and the Transvaal, and he communicated his Report to Lord Milner at the end of last year. The particulars here given are extracted from this Report, which has been communicated by the author.

The chief points of the Report are that all rivers and torrents should be proclaimed as public domain, if irrigation is ever to succeed in South Africa, and that Italian precedent is worthy of imitation.

When Victor Emmanuel consolidated Italy into one country, he decreed at the outset of his reign that the whole of the rivers and torrents of Italy were part of the public domain, and, as such, the property of the Government representing the people. Old irrigation rights of thousands of years' standing stood in the way of such legislation, but the Government of Count Cavour possessed a strong hand. Having decreed the rivers and torrents as public property, the Government in the same bold and decisive manner defined with great accuracy all the indefinite and vague claims of centuries, and then set itself to legislate for future concessions. Modern Italy owes much of its prosperity to this wise and strong legislation. The irrigation laws of Italy are given in great detail by Mr. W. Ham Hall, in his book 'Irrigation development, France, Italy, and Spain." There Italian irrigation laws, in great part developed by the ancient Romans, might be taken as a model for all arid and semi-arid countries in the possession of Europeans. It is to laws such as these that vast tracts in India and the whole of Egypt owe all their prosperity. And it is to legislation such as this that all thoughtful men in South Africa are looking forward.

Mr. Willcocks then describes the different sections of the three colonies in detail.

Cape Colony.—The Verkeerde Vale Reservoir is situated near the sources of the Touws River at a distance of some ten miles from the Touws River Railway Station. The vale is about 2,500 feet above sea-level. It is sufficiently near the south-western corner of the Cape Colony to have its more important rainfall in the winter months. The total rainfall is some 12 inches per annum. The reservoir itself covers 800 acres, and the average depth of the reservoir is five feet. The powerful Boksburg springs flow through the reservoir and help to sustain its level. A gauge has been read here for some fifteen years. The reservoir is generally at its highest in October, at the end of the winter season. As the winter and summer rains of 1896-1897 failed almost entirely, the reservoir continued to fall from the 1st January, 1896, to the 15th June, 1897, and was practically dry during the first six months of 1897. As such droughts occur periodically in the colony, provision must be made for them in all reservoirs for perennial irrigation in the dry regions of South Africa. Such a provision could be made for them at this reservoir by raising the floor of the escape sill and gradually raising the dam. The Hon. Dr. Smartt contemplated the raising of the dam by some eight feet. Such raising should be done very carefully, as the dam is in great part built of porous sand and lies on porous sand. The new earth should be thrown on the up-stream side of the existing work after the stone has been stripped off the surface. The water should not be allowed to rise more than one extra foot per annum. The wash of the waves on the dam, according to Mr. Whittaker, the State Engineer in charge, is exceedingly heavy in summer. In the Touws River Valley in years of ordinary winter rain, good wheat crops can be grown on the alluvium of the river. These crops might be made permanent by the construction of 15 feet high weirs at suitable sites, and the leading off of small canals from the up-stream sides.

After a very careful study of the rainfall statistics, and all the observations and calculations in the numerous able reports written by Mr. Gamble and his successors, I may say that for the Karoo one should not count on more than 1,000,000 cubic feet of storage water from one square mile of catchment basin in the Eastern Karoo, and 500,000 cubic feet of storage water from one square mile of catchment basin in the Western Karoo. Years of good rainfall and ordinary years will give more, but in years of low rainfall it would not be safe to expect more. Allowing for waste or evaporation, in ordinary reservoirs holding up 20 feet of water, each acre of land under perennial irrigation may be credited with requiring 250,000 cubic feet per annum in addition to the rainfall. It may thus be assumed that in the Eastern Karoo each square mile of catchment basin may be depended on for four acres of perennial irrigation. In the North-Western Karoo we may consider one acre of perennially irrigated land as the most to be expected from one square mile of catchment basin.

Orange River Colony.—The conquered territory of the Orange River Colony consists of that part of the Harrismith, Ficksburg, Ladybrand, and Wepener Districts which borders the Caledon River, and which, generally speaking, drains into the Caledon River. The country lies between 4,500 and 5,500 feet above sea-level, and has a rainfall varying from 25 inches near Wepener to 30 inches at Ficksburg and Harrismith, In this territory, as in Basutoland, the rainfall is generally sufficient in August, September, and October to allow of wheat being sown between June and August and reaped in December without irrigation. The agricultural value of the land improves as one approaches the Drakensberg, as the rains are more constant. The veld is covered with good grass, and agriculture is steadily on the increase. This tract is universally considered the best suited of any in South Africa for European settlers. The springs are numerous. In the Karoo no springs are met with in the hills, while those in the valleys have a general discharge of four cubic feet per minute. Here the springs in the hills run to four cubic feet per minute, and those in the valleys to 40 cubic feet per minute. Such springs are collected in reservoirs and are capable of working small corn mills. Wheat and Indian corn are the principal crops, and there are large flour mills on the Caledon and its tributaries, which can be worked for nine months per annnm. Mr. Newman has constructed a large reservoir by means of a masonry and earthen dam on the Liew River between Ladybrand and Thaba 'Nchu, and works a very important corn mill with the water power developed. Just below the mills there are large areas of land eminently suited for perennial irrigation on which the water escaping from the mills might, with great advantage, be utilised, but the proprietors have never used it. I was told that the proprietors were preparing to make canals and utilise the water when the war broke out.

In the north-eastern half of the Orange River Colony the good veld may be taken as £1 per acre, and the perennially irrigated land at £20 per acre. Of course it is understood that no reasoning man would think of perennially irrigating any but the best land in the country.

Here, as everywhere else in South Africa, water must be stored for irrigation. In all the rivers and creeks in this section I should store water in the manner proposed for the Caledon River Valley. Storage will be far simpler than on the Caledon River as the numerous stone dykes will provide excellent foundations. As the valley rivers are considerably steeper than the valley of the Caledon River it will be necessary to construct the weirs 25 feet high instead of 20. This, however, will entail no difficulty as the foundations will be everywhere on rock. The conversion of all the rivers into perennial streams by this method will provide ample water for the agricultural requirements of this tract for many generations, especially when it is remembered that Indian corn can be grown without any irrigation at all.

From inquiries, observation, and comparison with other countries, I should say that in those parts of South Africa which lie below 1,000 feet above sea level, and are situated in the arid or semi-arid region, a rent of £2 per acre per annum could be easily paid for perennial irrigation anywhere near a railway. In the semi-arid regions between 1,000 and 2,500 feet a rent of £1 10s. could be paid. Where the ground is over 2,500 feet in height, a rent of £1 per acre per annum could be paid. Allowing for perennial irrigation in nine years out of ten on the whole area, and for perennial irrigation in years of drought on only half the area, I think that, with labour-saving machinery and a capable man to design and direct the works, the cost of providing perennial irrigation from reservoirs in South Africa would vary from £7 10s. to £15 per acre. As the selling value of an acre of land not provided with perennial irrigation varies from 2s. 6d. to £3 per acre, while the price of good land provided with perennial irrigation varies from £20 to £100 per acre, irrigation works might be undertaken without any misgiving. It is understood, of course, that perennial irrigation would be provided for none but the best land.

Transvaal.—The Transvaal may be most conveniently divided for agricultural purposes into the dolomite region, the high veld, the low veld, the bush veld, and the south eastern tracts. Of these divisions, the most important in every respect is the dolomite region. It consists of the high plateaux on which the rain falls, of the belt of dolomite in which the water is stored, and out of which the springs have their birth; and of the sandstone and argillaceous rocks over which the water flows, and where it is principally utilised. Owing to displacement, the older rocks lie highest and the younger are less in altitude.

Johannesburg has the best rainfall in the district, which may be taken as ranging from 28 inches per annum in the east to 22 inches in the west. The maximum at Johannesburg may be taken as 40 inches and the minimum 20 inches. The rainfall, as everywhere in South Africa, is very uncertain in September, October, and November, while January, February, and March can always be counted on. Water for all the superior crops is needed from May to December. Indian corn, potatoes, pumpkins, and turnips can be sown and reaped without irrigation, and so also can side oats in most years. The country generally is capable of great agricultural development. The soil is rich and the rainfall generally abundant though misplaced. One may say that, owing to the rocky nature of the country, two-thirds of the area may never be fit for anything except veld grass, while the remaining third will be capable of agricultural development. The rainfall here is so good that each square mile of country may be considered as capable of supplying enough of water for reservoirs to ensure in years of drought 25 acres of perennial irrigation. This was the area irrigable in the best watered parts of the Orange River Colony. As the dolomite region stretches over 15,000 square miles, the total area capable of perennial irrigation may be taken as 350,000 acres, in addition to the areas irrigated by the existing springs. Reservoirs in the beds of the streams, or at the rocky gorges and passes in the hills, will be easily constructed by overflow dams some 50 or 60 feet high, as we have generally to do with hard rocks of great resisting power.

I have so far said nothing on the subject of land and water rates, and yet no wholesome improvements are possible in arid and semi-arid countries without land and water taxes of some kind. Without taxation an individual may possess a million acres of land and do nothing to improve it with perfect impunity. Others are prevented from improving it, the State cannot interfere and whole regions lie waste and barren. All Eastern Governments have realised this as they have generally to do with regions where Nature does so little and human beings have to do so much. Europe with its wonderful climate differs generally from this rule. In South Africa, however, the Government must follow the precedent of the arid and semi-arid regions of the world if it wishes to insure success.

There is scarcely any part of South Africa where agriculturists cannot afford to pay £1 per acre per annum for perennially irrigated land. It may be considered that a spring is capable of irrigating 150 acres per cubic foot per second, or 2½ acres per cubic foot per minute. It would be perfectly fair for the State to put on every perennial supply of water a tax of £2 10s. per cubic foot per minute, whether the irrigation were flow or lift. If the water was supplied by a natural spring or by an artificial reservoir created by the Government it would be taxed equally. Artificial reservoirs constructed by private parties would not be taxed. The perennially irrigated lands might be taxed instead of the water supplied, but the taxing of the water supplied would encourage economical usage, and has much to recommend it. Judging from the springs I have seen and the area on which they operate, I should say that the natural springs of the Transvaal would bring in a yearly revenue of from £150,000 to £200,000 per annum, which could be easily paid. The springs in the Orange River Colony would not bring in a tenth of this revenue. Artificial irrigation provided by reservoirs and canals from borrowed capital would bring a handsome direct revenue in these countries as it does in India. The indirect revenue would be a material gain to the Government of no inconsiderable amount. A uniform rate of £1 per acre per annum for perennial irrigation would enable extensive projects to be undertaken everywhere.

The author concludes his report as follows:—With the exception of the south-west corner of the Cape Colony, the "Conquered Territory" of the Orange River Colony, and the high veld of the Transvaal, the agricultural development of the whole country depends entirely on irrigation. The high lying plateau of South Africa has a rainfall suited to tropical countries, and a climate which belongs to a temperate zone. The autumn rains of February and March, which are monsoon rains, would, in a country like India, be of infinite value; but followed, as they are in South Africa, by a severe and biting winter, they are of little value indeed for agricultural purposes. The long winter and spring drought, and the uncertain summer rains absolutely prohibit agriculture of any advanced kind.

In about four-fifths of the Cape Colony, and in one half of the Orange River Colony, no crops can be grown without irrigation if there is to be any certainty of reaping a harvest. In one-fifth of the Cape Colony, half the Orange River Colony, and two-thirds of the Transvaal, Indian corn, potatoes, roots generally, and pumpkins, for feeding stock in winter, can be grown with the aid of the rainfall and matured in all but years of heavy drought. In these more favoured tracts an intelligent application of crop rotations, suitable manures, and good tillage would do much for the country, and in ten years out of eleven suffice for an agricultural development of no mean value, especially if taken in conjunction with stock breeding, which will always be the principal industry of the country. But even in such tracts the unfailing recurrence of famine in India has taught us that in countries where the rainfall is by nature tropical and confined in a great part to a few months of the year, there is no insurance other than perennial irrigation. If such is the case in the best favoured parts of South Africa, what shall we say of the rest of the country, when year after year millions of cubic feet of water roll away uselessly to the sea. The water comes when it is of no value, and is absent when it would be worth untold gold.

The extraordinary fertility of all those localities where nature has provided springs of perennial water, and where the farmers have been able to utilise it, in spite of the laws which are as harassing as they are ridiculous, points the way to the true road where lies the permanent regeneration of South Africa. We have only to imitate nature, and impound on the surface of the ground the same water which she stores in caverns and fissures, and we have put the permanent prosperity of the country on a sound basis. The Kenilworth Oasis, within a few miles of Kimberley, irrigated by the refuse water of the diamond mines, is a sure guarantee of what even inferior water can do with the rich soil and climate of South Africa.

In connection with this question, it is fortunate that nearly everywhere in the Transvaal, in the greater part of the Orange River Colony, and over wide areas of the Cape Colony, the rainfall is sufficient in quantity in even the very worst years to allow of the storage of water on a very large scale. On a rough calculation I should say that, with the aid of its rainfall and the Orange River, the Cape Colony should be able to ensure the perennial irrigation of 1,000,000 acres, the Orange River Colony of 750,000 acres, and the Transvaal of 500,000 acres in the high-lying regions where Europeans can live and work, and 1,000,000 in the low tracts, which should, I think, be thrown open to our fellow British-Indian subjects. On this latter point I have written fully elsewhere, and shall say nothing further here.

South Africa with an additional 3,000,000 acres of perennially irrigated land gained at an expenditure of £30,000,000, and valued at £100,000,000; and also with 10,000,000 acres of land under crops depending on rainfall, which might be valued at another £100,000,000, would be a very different country from that which it is to-day. An addition of £200,000,000 to the permanent wealth of South Africa would enable the country to contemplate with serenity the dark days of its gold and diamond industries. Without such agricultural wealth to lean upon, the exhaustion of its mines will plunge the whole country into conditions of poverty which no statesman can contemplate without dismay.

Obituary.

JOHN HALL GLADSTONE, Ph.D., D.Sc., F.R.S.—Dr. Gladstone, the eminent chemist and physicist, who was an old and prominent member of the Society of Arts, died suddenly in his house at Pembridge-square on Monday, 6th inst. He was born in 1827, and studied chemistry under Thomas Graham at University College, London, and under Liebig at Giessen University. He was Lecturer at St. Thomas's Hospital from 1850 to 1852, and was elected a Fellow of the Royal Society in 1853. He received the Davy Medal of that Society in 1897. He was a member of the Royal Commission on Lights, Buoys, and Beacons from 1859 to 1862, and of the Gun Cotton Committee (War Office) 1864-68. He held the office of Fullerian Professor of Chemistry at the Royal Institution 1874-77; was the first President of the Physical Society 1874-76, and President of the Chemical Society 1877-79. He wrote a large number of papers on subjects connected with Chemistry and Optics, which were published in the "Philosophical Transactions." and the other publications of scientific societies, besides publishing several substantive works, Biography of Faraday 1872, Spelling Reform 1878, Chemistry of Secondary Batteries 1883, &c. He devoted a large portion of his time to the work of the London School Board, of which he was a member from 1873 to 1894; for three years of this period he acted as vice chairman. He was elected a member of the Society of Arts in 1874, and read several papers on scientific and technical teaching in elementary and evening continuation schools before the Society. He also took the chair on occasions when educational subjects were discussed at the evening meetings. Dr. Gladstone took a keen interest in philanthrophic and religious movements. The obituary notice in *The Times* concludes with the appreciative testimony that "his death terminates a long career of solid and useful work in many fields, always carried out with unostentatious modesty and urbanity."

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Proceedings of the Society.

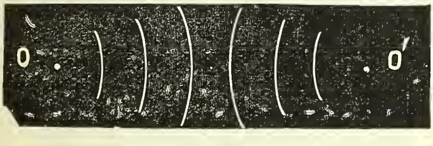
CANTOR LECTURES.

GLASS FOR OPTICAL PURPOSES.[*]

By Richard T. Glazebrook, M.A., D.Sc., F.R.S.

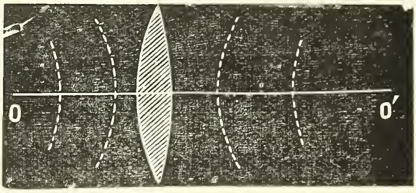
Lecture I.—Delivered April 14*th*, 1902.

Fig. 1.



I am to speak to-night, and in the succeeding lectures of this course, on "Glass for Optical Purposes," and especially I take it on the modern glass that is now so generally used. At the same time I think it desirable, by way more or less of introduction to the subject, to say something in this first lecture as to what the optical purposes are for which we wish to use the glass, and as to what it is that the glass which we use has to do. I take it that in almost all cases we desire to make an optical image of some object, be it a distant object or a near object, and the problem before us is how to utilise our material to the best advantage in order to make that image. Now let me ask what do I mean by an optical image of an object? Suppose for a moment that I take a single point from which rays of light, or preferably waves of light, are travelling, these waves diverge outwards from the point O, Fig. 1, in spheres, and the radii of the spheres constitute what we call the rays of light. If I wish to form an optical image of that point somewhere else—at O′ for example —I must so arrange things as that these diverging spheres may be transformed into converging spheres, converging on to the point O′. So that instead of having the light diverging from a point, after passing my optical system—a series of lenses—the waves are made to converge in spherical form to the point at which I wish to produce the image. And now, how comes it about that we can obtain this result, and cause the waves of light to change from diverging into converging spheres? We are able to do this in consequence of one or other of two properties. We can do it either by the reflection of the waves from some surface or we can do it by the refraction of the waves. The waves diverging from O fall on a lens or series of lenses, Fig. 2. Now in order that I may change the waves from diverging spheres to converging spheres, I need to flatten the central part and bring the edges forward. We take advantage of the fact that in most transparent media light travels more slowly than in air, so that if we put a considerable thickness of the medium in the way of the central portion of the wave, and a less thickness of the medium in the way of the outer portion of the wave, it will be possible so to retard the centre relatively to the edges that the form of the waves is changed from a series of diverging to a series of converging spheres, and that is exactly what we wish to do. And by this process the rays are bent. With all the optical apparatus with which we are concerned, we make use of the refraction or bending that takes place when light passes from one medium to another one. And I want in the first instance to show on the screen a number of slides which will illustrate that refraction and bending of light in various cases. The first case shown in Fig. 3 is the very simple one of the passage of a ray of light or a series of rays of light through a prism. A pencil of light diverging from A along the

Fig. 2.



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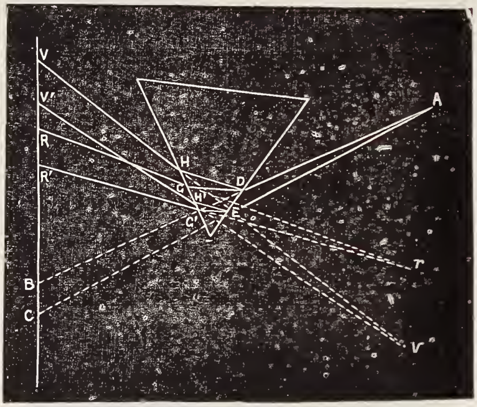
[*] The blocks illustrating these lectures have been kindly lent by the Editor of *The Optician and Photographic Trades Review*.

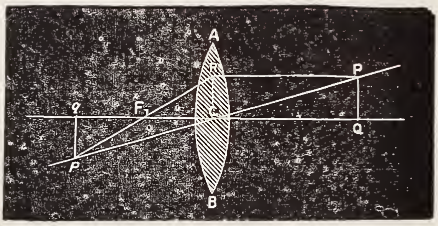
lines A D B and A E C is bent, in consequence of the refraction of the glass, and is split up into its component coloured rays, the red rays diverge from r, the violet from v, and a coloured blurr of light extending from V to R′ is seen on a screen behind the prism. I think this is probably known to all.

FIG. 3.



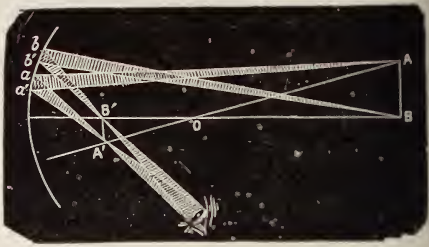
I want you to notice, however, that the rays of light are bent upwards towards the thicker end of the prism or refracting medium, and we can show, if we want to get a greater amount of refraction or bending, that we can do it by increasing the angle between the two refracting surfaces. If we want to make a lesser amount of bending we do it by decreasing that angle. The next slide is intended to show the passage of a ray of light through a convex lens, a portion of a transparent medium with two spherical surfaces.

FIG. 4.



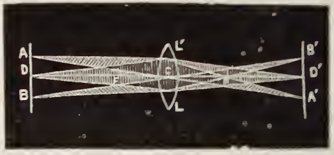
A ray coming in along P R is refracted downwards. If the lens were perfect then all rays from P would be so refracted by the lens as to be brought by a focus at p; an optical image of P would be formed at p. But now, lenses, as we shall see, differ in reality from perfection, and produce quite other effects than those which are produced by a perfect lens. It is their defects with which we shall be particularly concerned. This next figure also show the production of an image, in this case, no by a lens, but by reflection, by a mirror.

FIG. 5.



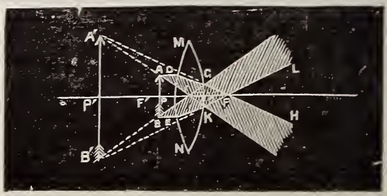
Her the action is practically the same, and o course in a number of our optical instrument we are concerned with the action of mirrors The waves of light travelling from A as a serie of diverging spheres are made by the action o the mirror to form a series of convergin spheres with A′ as centre, and all the rays o light from A unite at A′ and form at A′ ar image of the point A. In this figure the imag formed is a perfect image, because all the rays are made to unite at A′. Fig. 6 again shows the formation of a real image by a convex lens

FIG. 6.



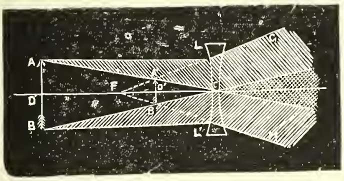
Rays of light coming from A are made by th convex lens to converge to A′; rays from B t B′, and so on, and an image A′ D′ B′ is formed of the object A D B. Such an image is called a real image because the rays of light that start from A converge to A′ and actually pass through A′; so that if we put a screen at A′ B we could see from any point of the room th real image of A B. In Fig. 7, again A B is our object. Rays of light falling on the convex

FIG. 7.



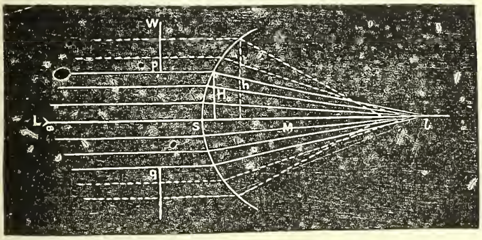
ens are bent by the lens, and are made in this case not to converge to a point to the right of the lens but to appear to diverge from a more distant point A′, behind the lens; while rays from the point B are made to appear to diverge from the more distant point B′; and, therefore, if I were to place my eye behind this lens, the light, that falls on the eye, instead of appearing to come from A B would appear to come from A′ B′, and I should see a magnified image A′ B′. Here in Fig. 8, is a concave lens, or diverging lens, which spreads the light rays out more. The rays of light travelling along A C are made to diverge more, and appear to come from A′. Rays from B appear to come from B′. The rays issuing from the lens are more divergent than the rays issuing from the object. Such a lens would of course diminish the object.

Fig. 8.



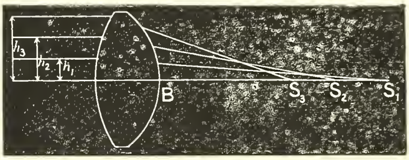
So far then for the action of what may be called perfect lenses. Now in the next series of figures we shall see what some of the defects of lenses are. Fig. 9 is drawn somewhat carefully to illustrate the refraction of light coming from a considerable distance away to the left, and incident upon a spherical surface.

Fig. 9.



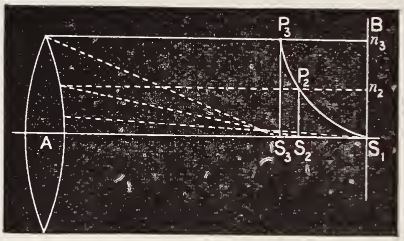
Consider the rays that are fairly close to the line L *l* which is called the axis of this system; those rays are made by refraction to converge and to meet with considerable accuracy at this point *l*; but if we go to a greater distance away from the centre line, then, owing to the action of refraction, the upper rays are refracted more than is sufficient to bring them to a focus at *l*. They travel along the dotted lines. So that, if we have the whole of this spherical surface refracting light, instead of getting formed at the point *l* a clear and distinct image of the distant sourse of light, instead of, that is to say, having a series of spherical waves all converging to *l*, we have waves from the centre converging approximately to *l*; from the outer portion of the surface they converge to a point much nearer the surface than *l*, and from intermediate portions to points on the axis between these. There is in that case what is called spherical aberration produced. The next (Fig. 10) will illustrate the same thing, only with a complete lens drawn. We have a lens with light falling on it, the centre portion of the rays are brought to a focus at S_1. From points further from the axis they come to S_2; from the outermost points to S_3 and so we do not get a simple image anywhere of the distant object, but a series of more or less blurred spots. Now the surfaces of the lens as I have drawn them are portions of spheres. It is pretty clear how we might correct this lens so as to bring all the rays to a focus more nearly at the same point. It is clear that the upper portion of this lens refracts the rays too much, they cut the axis in front of the rays from the centre. Therefore if we could flatten our surfaces at the edge so as to have less curvature there, we should probably be more successful in bringing the rays to one focus somewhere between S and S_3. Of course, however, we must remember that for practical purposes it is necessary to work with surfaces that are portions of spheres, because if we do not do that we are stopped by the very great difficulty of working the shapes of the lenses accurately and exactly; and it can be shown, if we examine the question more completely and more fully, that we cannot in any case completely correct spherical aberration for such a single lens, though we can by properly choosing the shape of the lens make it very much less than in the figure. Now I should like to explain how we may make a diagram which will show us the amount of spherical aberration in the case of any lens.

Fig. 10.



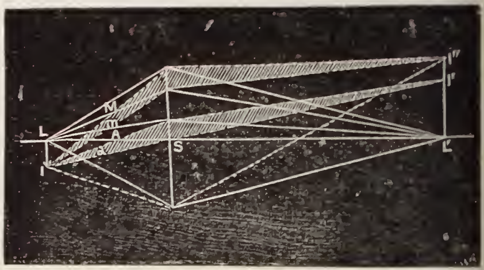
Let the line A S_1, Fig. 11, represent the axis of the lens. Let us take a line S_1 B at right angle to the axis, and suppose that the central rays come to a focus at the point S_1; let us divide the lens for simplicity into three parts, and assume that the rays from the central part meet the axis in S_1, those in the middle zone in S_2, and those from the outer zone in S_3: of course, in this figure, the displacement of the focus is very greatly exaggerated. Now suppose we take points n_2, n_3 on the vertical line S_1 B to represent the zones as it were, and through n_2 and S_2 draw horizontal and vertical lines P_2 n_2 and P_2 S_2 to meet in P_2. Then P_2 may be taken to represent the aberration of the zone represented by n_2; similarly P_3 obtained in the same way represents the aberration at n_3. Now if instead of three zones we took a large series, we should obtain a series of points like P_2 or P_3; these points would lie on a curve, and by means of this curve we can represent the aberration due to each zone of the lens. Hence it is clear if we want to get rid of the spherical aberration of the lens we must make the curve as nearly as possible coincide with the vertical line B S, and one of the objects that we have to aim at in making lenses will be to succeed in bringing the curve as close as possible to the vertical line. We shall have to examine later how that can be done. This then is the first serious error of a lens which we wish to correct, the error due to spherical aberration.

FIG. 11.



Now, in the figure I have just drawn, and the statement I have just made, I have assumed that the source of light was on the axis of the lens, and we can suppose that the lens has been corrected in such a way that rays of light diverging from a point on the axis are now made to come to a focus at the point S_1, *i.e.*, that we are working with a lens which has been corrected for spherical aberration—what then is the next thing we have to deal with? In almost all cases we are not concerned solely with a source of light which lies strictly on the axis of the lens. We are concerned with forming the image of an object, which is in many cases somewhere near the axis of the lens, but not exactly on it. We have got then a small object, as L l of Fig. 12, and we are going to consider the formation of an image of this small object produced by a lens at S. The lens has been corrected for spherical aberration so that the image of L, the centre of the object, is supposed to be at L′. Now we can again divide up our lens into a series of zones. We take the central zone first. The elementary theory of lenses enables us to calculate, on certain assumptions, the position of the image of l, which is not on the axis formed by the centre portion of the lens, and this is found at the point l'. Does it follow that if we consider a pencil of rays which falls on the lens at some considerable distance away from the axis, it will also form an image of l at l'? It does not so follow; the image of l formed by such rays would in general be at l'', and the condition that the image of l as formed by rays which travel near the edge of the lens shall be at l', *i.e.*, that l'' should coincide with l', is an important condition. That condition is known generally to opticians as the sine condition, because if you call U the angle at which any ray makes with the axis of the lens, and if you call U′ the angle which the corresponding refracted ray makes with the axis of the lens, the condition that these two images l' and l'' should coincide requires that the fraction obtained by dividing sin. U by sin. U′ should be the same for any two corresponding rays. I do not think I need trouble now as to how this comes about: but in order that you may get a good image of a small object placed at L, formed at L′, you must have this sine condition satisfied for all possible rays. Now it is not difficult to show that this sine condition, generally speaking, will only be satisfied for two points for which the lens has its spherical aberration corrected. These two points are known as the aplanatic points, and

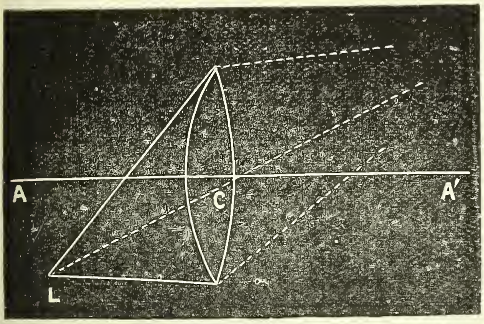
FIG. 12.



a lens which has satisfied these conditions is said to be an aplanatic lens.

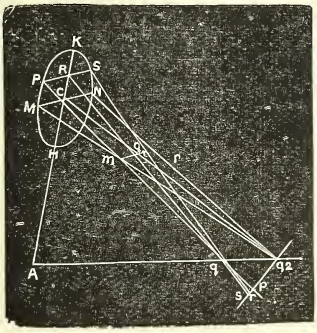
So far I have only dealt with rays of light which fall on the lens in a direction more or less nearly coincident with the axis of the lens.

Fig. 13.



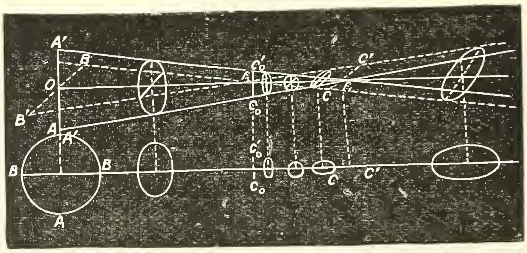
The axis of the pencil of rays has not been supposed to fall obliquely on the lens. I now come to the defects produced by oblique incidence. In Fig. 13, A C A′ is the axis of the lens. Light from a point L falls obliquely on the lens and is refracted; we wish to consider what happens to it. This is shown in Fig. 14, in which I have not drawn the incident rays of the pencil. The figure H M K N represents the portion of the lens on which the rays fall, and these rays coming from a point behind the lens are refracted. The refracted rays are

Fig. 14.



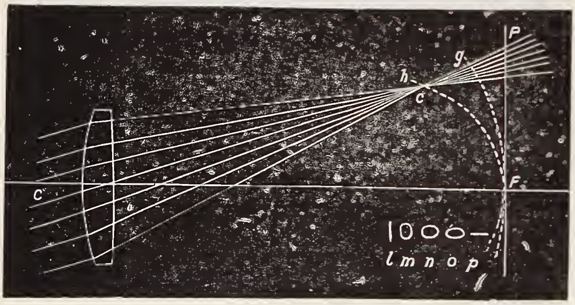
drawn, and you will notice that they pass very approximately through two straight lines r q_2 and m g_1. There is no point anywhere through which all pass. These rays are supposed, of course, to be formed by refraction at a spherical surface according to the ordinary laws of refraction. There is no point through which all the rays will pass, they will pass approximately, however, through two straight lines called focal lines; the one straight line m q_1 is at right angles to the paper, and is called the primary focal line; the other r q_2 is in the plane of the paper, and is called the secondary focal line. What we want to remember is, that when the rays are incident obliquely on a refracting surface such as this, we do not get—unless we correct the action of the lens—we do not get the rays converging to one point, but to two straight lines, a primary focal and a secondary focal line which may be behind or in front of it, according to the properties of the lens. I have one or two other slides to show this, and to illustrate shortly how we can correct or get rid of this defect. In Fig. 15, A B A′ B represents a portion of a surface on which rays of light are incident; some of these rays are drawn in the figure, and the curves below are intended to show what is the shape of a section

Fig. 15.



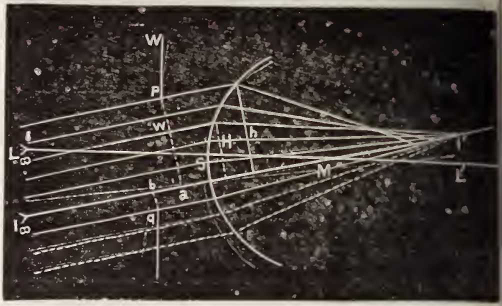
of that pencil of rays as you take a screen back from the lens itself through the pencil. The section is circular at first, when you get a little distance away it becomes more or less elliptical with its longer axis vertical. As you get further and further away it becomes a straight line C_0 C_0' one of the focal lines. As you go further away again the section becomes slightly elliptical, and finally some little way further you get a point at which it is more or less approximately a circle, this is known as the circle of least confusion. As you pass on further you get an elliptical section again, but the axis of the ellipse is at right angles to what it was previously. Then you come to another straight line CC′, which is at right angles to the first straight line. This gives you the form of a pencil of rays, which are supposed to diverge from a point, and which fall on a lens obliquely, after they have traversed the lens. So that if you were to receive these rays on a screen, you would nowhere get on the screen a sharp clear image of the point from which the rays diverge. You would get a circular blurr becoming more or less of a straight line near the focal lines. The problem then that we have before us if we wish to form an image when working with light which is falling very obliquely on a lens, is how to alter the surface—the shape of the lens—or to combine the lens with one of a different class, so as to bring together the two focal lines and make them coincide with the circle of least confusion, making that circle very small indeed, practically a point. When this is done the lens is said to be stigmatic; we want to correct the astigmatism of our lens, the fact that it does not bring the rays of light to a point. We shall see shortly how we can do that. I have now got here one or two slides showing the action of lenses of different kinds in producing astigmatism. Here is one, Fig. 16, which I got from Mr. Dennis Taylor who used it in a paper read before the Photographic Society a short time ago. It is intended to represent the astigmatical effect in a lens having the shape shown. The primary focal line is *h*, and the secondary focal line is at *g*. And as you come down nearer and nearer the axis, as you get the inclination of the axis of the pencil to the axis of the lens less and less, these two, primary and secondary focal lines, will more nearly coincide. The dotted curves show the position that will be taken by the primary and secondary focal lens as the obliquity is reduced, and you see that the distance between the lines is reduced as we approach the axis. And the problem that we have to solve, if we can, is to bring these two curves as close together as possible, and also, if possible, to make them coincide with the straight line, F P. And then all the image-points will be points lying on this line F P at right angles to the axis of the lens.

Fig. 16.



The next slide, Fig. 17, is intended to show another form of astigmatism. Suppose that we are dealing now with a lens or with a surface which is corrected for spherical aberration, and suppose that the corrections are such that if you limit the incident pencil of rays by an aperture which is indicated on the figure by P, Q, then for a pencil of rays having a half breadth H equal to the distance between P and the axis, the lens is supposed to be corrected; so that if you have such rays incident parallel to the axis, they will all be brought to a focus at the point L′. The lens is corrected then for a distance H on either side of the axis. Now suppose the axis of the incident pencil of rays is oblique, instead of direct, let it be the line I I′. Remember that the aperture of the lens for which it is corrected is only of a breadth H on either side of the axis, and consider what are the rays that can fall on the surface. They are not only rays at the distance H from the axis, but rays between P and *a*, which is a greater distance than H, so that if you allow rays to fall obliquely on the lens you are using for the one side of the lens a greater portion of the lens than that for which it was corrected, and for the other a less, and therefore the rays are not brought to a focus at the point I. Hence, although the lens was corrected for an aperture of breadth 2 H, so long as the rays are incident parallel to the axis, it ceases to be correct when you get the oblique pencil of rays. Above the axis the aperture is greater than H; rays, therefore, are admitted which do not converge to I below the axis rays which should go to make up the image I are wanting. So that the image formed in that kind of way from such a lens is a lopsided sort of thing, and the result is, even if the focal lines are close together, that instead of obtaining a round, sharp image of the source, you get, in a case of that kind, a blurred pear-shaped spot. This is the defect of the lens which is called coma. Here are two figures lent me by Mr. Taylor, drawn so as to show the defect of coma due to the action of the stop. These lenses are cor-

Fig. 17.



rected for a narrow stop; but if the full set of rays is allowed to enter, the various rays will intersect at different points, and the result is the nearest approach to an image which is formed will be as shown in the lower part of the diagram. This is shown in Fig 18. The image will be affected by the defect coma. The next figure (19) shows exactly the same thing, only drawn so as to produce the defect in the other direction. We have then to correct these defects if we can.

Fig. 18.

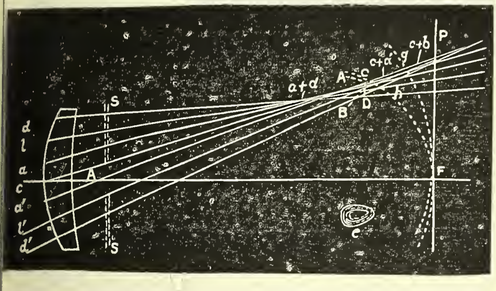
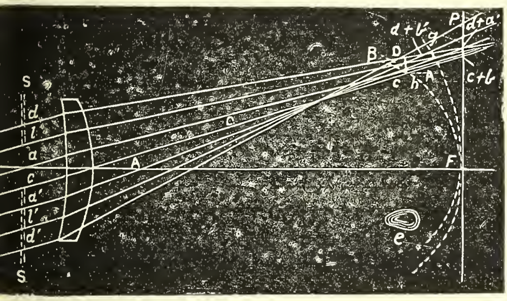


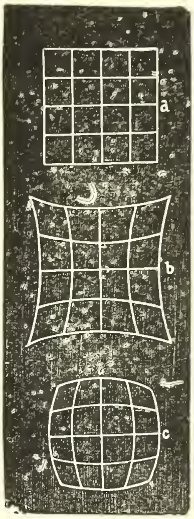
Fig. 19.



And here, in Fig. 20, is shown the final defect of this kind, the defect known as distortion. The object of a lens is to produce an image of some distant object which shall be exactly similar to the object itself. Now it may happen that if we take any object of the form shown — a series of vertical and horizontal lines — the images produced will consist of a series of curved lines as in the diagam. A lens forming an image of that kind would produce distortion in the picture.

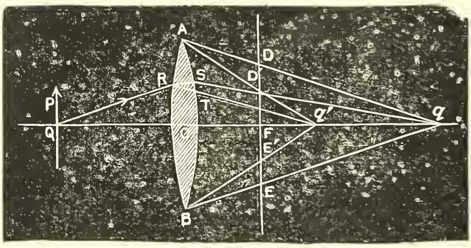
So now to sum up. When dealing with lenses, we have to consider the defects due to spherical aberration, the aplanatic condition, the condition for astigmatism, for curvature of the field, and for prevention of distortion. And we shall see in the following lectures how we are going to get rid of these defects.

Fig. 20.



There is, however, another series of difficulties to deal with, and these are due to the fact that white light has different degrees of refrangibility. I said that refraction was due to the fact that light travels with different velocities through different media; and now we have to remember that white light consists of different coloured rays, which travel with different velocities in any one medium, so that if we had a pencil falling on a prism as in Fig. 7, the rays will be split up as shown in that figure. The red rays travel at a greater velocity than the blue rays, and the blue at a greater rate than the violet, thus the rays are spread out as a coloured spectrum. These defects will be shown in our lenses. If we have a convex lens, such as is shown in Fig. 21, then any ray, such as Q R, falling on the lens is split up by the action of the lens into a violet ray R T q' and a red ray R S q.

Fig. 21.



And if the lens is aplanatic for the red light then all red rays will converge at q; while at q' we should have a violet image, assuming it also aplanatic for violet. That is the defect called chromatic aberration. The next slide will enable us to see how chromatic aberration can be corrected. If I take two prisms having the same angle but of different material—one of crown glass and the other of flint glass—then I find that the length of the spectra which they produce is very different. Fig. 22 shows the length of the spectrum produced by a crown glass prism, and that produced by a flint glass prism, so that for prisms of about equal angle the flint glass spectrum is much longer than the crown glass spectrum. If then I alter the angle of the crown glass, and make it greater, I can get spectra like those shown in Fig. 23, the one of flint glass and the other of crown glass, both being practically the same length. And now, if I put two such prisms, one behind the other, turning the angles in the opposite directions, then I can get a resultant bending of the ray of light on passing through the two; but since the spectra due to the two are of the same length, I obtain on the whole a colourless image. The prisms are corrected for chromatic aberration. Going back to Fig. 21, we see that a convex lens produces a violet image of the object near the lens, and a red image at a distance. Now if we use a concave lens such as is shown in Fig. 24, and if the light falls on it in the direction R Q, the violet image is produced at q', and the red at q, and by superimposing these two lenses, one behind the other, as in the next Fig. 25, the light is refracted by the convex lens, so as to produce a violet image at q' and a red at q; but the rays are refracted upwards by the concave lens, the violet, again more than red, so that the result is that the two images coincide at the point Q′. And we have formed at Q′ a white image of Q. But this alone does not by any means complete the chromatic aberration correction. There are other points to be considered. I only wish at present to call attention to the defect. And now you have got before you all the defects that we are going to consider one by one.

FIG. 22.

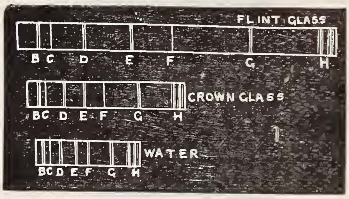


FIG. 23.

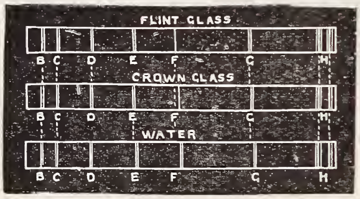


FIG. 24.

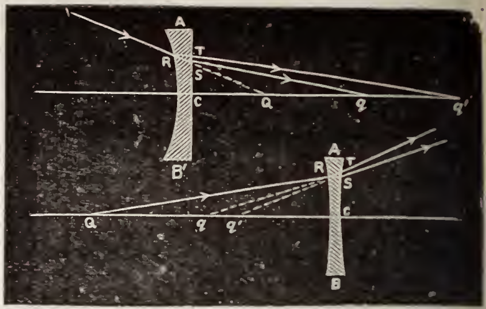
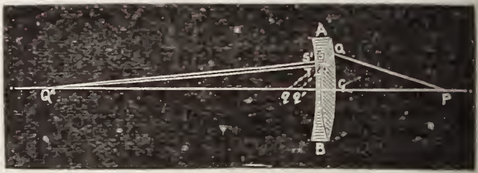


FIG. 25.



I am, however, to speak to you of glass, the material of which these lenses and prisms is made, and it will probably be interesting to refer a little to its history, and the method of its manufacture, what its constituents are, and so on. The origin of glass appears, as far as I can trace, to be entirely lost in antiquity. Practically, some of the very earliest memorials that we have seem to show that the men living then were acquainted with glass and with some of its properties. I believe that there are records of Egyptian origin that go back at least two thousand years before the birth of Christ, which show pictures of glass bottles and the manipulation of glass blowing, and so on, figured on the tombs. In Roman times glass blowing was a well known art. The glass manufactures of Alexandria were very celebrated indeed, and from Alexandria, the art travelled to Italy, to Venice, and, of course, the Venetian glassware is known and celebrated at the present day. In England, as far as I can trace it, there was not much known about glassmaking in the middle ages; but flint glass, which is the basis of the optical glass about which I am to treat, was first made in England, probably about the year 1620, although the date is not quite certain.

Glass is a mixture, in almost all cases, of silicates of two or more metals—at any rate two metals are necessary—and silica is necessary. And generally one of the metals is an alkaline earth. Here is a Table taken from the article on glass, in the "Encyclopædia Britannica," by a very well-known glass manufacturer, who has done much for the manufacture, showing the main constituents of glass.

TABLE GIVING MAIN CONSTITUENTS OF GLASS.
(From the "Encyclopædia Britannica.")

ACID.	ALKALINE.	EARTHY.	
		Colourless.	*Coloured.*
Silica	Oxides of	Oxides of	Oxides of
Boracic Acid	Potassium	Calcium	Iron
	Sodium	Lead	Manganese
		Barium	Copper
		Strontium	Chromium
		Magnesium	Uranium
		Aluminium	Cobalt
		Zinc	Gold
		Thallium	

MATERIALS USED IN VARIOUS GLASSES.
(From the "Encyclopædia Britannica.")

Crown Glass.	
Sand purified	100 parts
Chalk or limestone	35 to 40 ,,
Sulphate of sodium	40 to 45 ,,
Cullet	50 to 150 ,,
Plate Glass.	
White quartz or sand	100 parts
Sodic carbonate	33·3 ,,
Lime	14·3 ,,
Manganese peroxide	0·15 ,,
Cullet	100 ,,
Flint Glass or Crystal.	
Fine white sand	100 parts
Minium (red lead)	66 ,,
Refined potash	33 ,,
Nitre	10 ,,
Cullet	60 to 100 ,,

You have as acid material, silica, and very often some boracic acid. You have as the alkaline material, oxides either of potassium or of sodium, and then you have, as other material that you combine with those, oxides of, one or more may be, of the materials given in the last two columns. For coloured glass you use the one series, and for colourless glass the other. These materials are all mixed together in proper proportions. The whole is then dried, pounded up, and then put into a furnace at about 1,400°C, and kept molten for a long time. I need not trouble you with the chemical formulæ which have been given to represent the various kinds of glass. In the next Table are the materials used in crown, plate, and crystal, which last is the basis of our optical glass. Crown glass is made of purified sand, chalk, or limestone, and sulphate of soda. These are ground up and mixed with broken pieces of the glass you are making such broken glass is called cullet. It has been found desirable to mix in a certain quantity of broken glass with the raw material. Flint glass or crystal is made of very fine white sand and red lead, and a little nitre. Now the difference between optical flint glass and any one of these glasses, consists firstly in the fact that for optical purposes the glass has to be homogeneous. You will notice this flint glass or crystal, which is the material which forms the basis of many optical glasses, contains red lead, a very much heavier substance than the others in the glass, and the result is, that if you try to make optical glass in the ordinary way, the lead tends, as the glass cools, to sink down to the bottom. The glass is striated and not homogeneous, and the first thing to do is to render it as nearly as possible homogeneous throughout. The method of securing this was first discovered by P. Guinand, of Brenets, in Canton Neuchatel, Switzerland, who was born about 1740. He was the son of a working carpenter, and was entirely uneducated: when he began to make glass he could hardly write or read. He was brought up first as a carpenter, and he then became a cabinet-maker, and later a watch-case maker. While engaged in this occupation he became interested in optical instruments of various kinds. Through the kindness of M. Jacques Droz, who had one or two telescopes, Guinand was allowed to take a valuable telescope to pieces. He then thought he would like to make lenses, being urged to this partly by his wish to make spectacles for himself. Shortly before this time Dollond had discovered that by means of combining lenses of crown and flint glass you could secure a large amount of achromatism in a telescope. Through M. Droz, Guinand became acquainted with one of Dollond's lenses, and heard of the great difficulty of making the glass perfectly homogeneous. He then set to work to overcome this difficulty, and discovered that he could get the glass much more homogeneous provided he arranged for its very slow melting and cooling, and for continued stirring. I am not sure that this is the whole of his discovery, but at any rate it is accepted as such, and Guinand was the first to make fairly large lenses from masses of flint glass cast by himself sufficiently homogeneous to be used for optical purposes. He made several such lenses, and finally his success became known to a glassworker named Urt Schneider, of Munich, who persuaded him to migrate from Switzerland to Germany, and to start a glass works. For some time they worked together preparing glass, with more or less success, being joined after a time by Fraunhofer. Finally, however, Guinand got tired of the partnership, and returned to Switzerland, and again started making glass on his own account. He had, however, to forego an annuity paid him by Urt Schneider so long as he remained idle. After his death his son told the secret to George Bontemps, of Paris, who came to work with him; and Bontemps carried the secret and the method back from Switzerland to Paris, where he set up glass works. Bontemps was finally brought by Messrs. Chance Brothers to Birmingham, which has been the home of optical glass making up to the present day; and the furnaces and pots, which by Messrs. Chance's kindness I had the opportunity of seeing the other day, are, I understand, practically the same as those originally set up by Bontemps. For many years Birmingham and Paris were the only places at which this optical glass was made.

In the next lecture I hope to go on to describe more fully the actual methods of correcting lenses for the various defects that I have mentioned to-night. I must apologise for having occupied so much of your time with facts which are so well known; but I wanted to make clear to all present these various defects, so that the methods of correcting them might be the better understood. I have here one or two lenses very kindly lent me by Professor S. P. Thompson which will show the defects. I should say that the lenses are as bad as I can get them, for the purpose of exaggerating the defects very much. The lecturer proceeded with these lenses to illustrate the defects he had described.

Miscellaneous.

LUMINOUS BACTERIA.[*]

Many instances of light-production occur in Nature amongst plants and animals. This luminosity is most strikingly exhibited by marine animals and by minute vegetable-cells belonging to the group of the bacteria. Light-producing by living protoplasm is a process intimately bound up with the life of the organism, as in the case of the luminous bacteria. The luminosity of mineral and other inert bodies is dependent on an extraneous light source.

Amongst light-producing organisms our knowledge of the processs is most exact in the case of the bacteria. Their simple semicellular structure, and the fact that modern bacteriological methods enable us to isolate and study particular organisms, renders it somewhat more easy to study the conditions under which light-production can best occur. The observations which are embodied in this paper were made on luminous bacteria. These organisms are to be found mainly in sea-water and on dead marine animals. They are widely distributed in this respect. We have obtained and studied the most important types. About twenty-five varieties have been described, but it is probable that some of these are very closely related, if not identical. A hitherto undescribed form has been isolated from sea-water in the course of investigations made by one of us at Plymouth. It belongs, like most of the other species, to the group of the bacilli. The temperature conditions as regards growth vary considerably, and range from zero to 37° C.

The luminosity of the sea is mainly due to higher forms of marine life and not to bacteria, at any rate in northern latitudes. On the other hand the phosphorescence of dead objects, such as fish, &c., is due to bacterial forms of life. We have not been able to confirm the statements that luminous bacteria have direct infective properties as regards crabs and other marine animals. These organisms require particular and exact conditions in order to exhibit their luminous properties. They must have a suitable nutrient sail containing such proportions of salts as shall render the medium isotonic. For example, sodic chloride, if present to the extent of 3 per cent., will render the organisms luminous and ensure their remaining so for some time. In this manner they can be readily cultivated and studied in the laboratory.

The luminosity appears to be a function of the living cell and can be disturbed by any process which interferes with the vitality of the cell itself. The dead cell is non-luminous, whilst antiseptics which kill the cells inhibit at the same time their luminosity. A supply of free oxygen is essential; in the absence of oxygen the organisms live but are non-luminous. There is no evidence of a bacterial product as the source of the light. The process appears to be the result of an active oxidation occurring within the cell. The light produced is confined to a small portion of the visible spectrum, and invisible radiations have not been detected. As the spectrum of none of these luminous organisms extends even to the red, it may safely be assumed that no heat radiations are emitted. The light is produced without heat. No invisible radiations allied to the X-rays were detected. Photographs have been obtained by the aid of the light emitted by these organisms. The time-exposure required is, however, considerable.

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[*] Abstract of paper read by J. E. Barnard and Allan Macfadyen before Section K, British Association, Belfast.

An exposure to the temperature of liquid air does not destroy the luminosity of the organisms. It has been found possible to triturate bacteria at the temperature of liquid air by means of special methods devised at the Jenner Institute of Preventive Medicine. The luminous bacteria mechanically broken up in this manner ceased to phosphoresce. The luminosity, therefore, is due to the vital processes of the cell, and essentially depends for its origin on the intact organisation of the cell.

We have brought these results forward because this interesting group of organisms have not hitherto, so far as we can trace, been studied in this country.

WIRELESS TELEGRAPHY.

The Times gives an account abstracted from the official report of the experiments in wireless telegraphy which were carried out on board the Italian warship *Carlo Alberto* during the months of July, August, and September of this year. The report is written by Lieutenant Luigi Solari, of that ship, and is signed by its commanding officer, Admiral Carlo Mirabello. The apparatus was presented to the *Carlo Alberto* on its visit to England by Signor Marconi, who himself superintended its installation. It consisted of two of the recently invented Marconi receivers, with a metallic powder coherer, by means of which the signs are registered upon the ribbon of an ordinary Morse machine, to which were added three magnetic detectors, coupled to a telephone, and arranged in the manner that is shown in the "Note upon the Magnetic Detector of Electric Waves which can be Employed as a Receiver for Space Telegraphy," written by Signor Marconi, and communicated to the Royal Society by Professor Fleming on June 12th, 1902.

The transmitting station was Poldhu, in Cornwall, the place which had been chosen by Signor Marconi for his experiments in transatlantic telegraphy. After a few successful attempts at transmission over a short distance, the *Carlo Alberto* left English waters on a mission to Kronstadt, and a series of long-distance messages were conveyed to her from Poldhu with almost unbroken success throughout her voyage. The main difficulty encountered seems to have been in atmospheric disturbances of the ordinary kind. We read in Lieutenant Solari's journal:—

"At 1 o'clock in the morning of July 23rd, while the ship was on the north-east of the Island of Gothland in the Baltic, *en route* for Kiel, signs were obtained upon the telephone of the detector so distinctly that it was difficult to believe that 2,000 kilomètres of land and sea were interposed between the *Carlo Alberto* and the transmitting station in Cornwall. At 2 o'clock, however, the reception of the messages began to be broken by frequent atmospheric disturbances; it was no longer possible to receive the wave messages as they arrived with any certainty or regularity upon the receiver with coherer, but upon the telephone of the detector it was possible to distinguish fairly well, without any loss of force, the letters which arrived between the succeeding atmospheric disturbances, so that, giving the speed of transmission from Poldhu at about 15 words a minute, it was easy to decipher the telegrams sent from Cornwall."

Further experiments aided the operators in excluding the interference of atmospheric disturbance almost entirely; but in all such cases it would appear that the magnetic detector proved to be the most trustworthy machine, the ordinary receiver with coherer being too easily deranged by outside electric influence.

The most striking results were those obtained off the Spanish coast and in the Mediterranean. While lying off Ferrol the *Carlo Alberto* regularly received news every day of the principal events in the world; a daily bulletin of this news was posted in the ship and quite put to shame the last intelligence of the Spanish newspapers. At Gibraltar the *Carlo Alberto* came to anchor in the innermost part of the bay, and nevertheless, in that screened and secluded position, received an important telegram from Poldhu, of which every word arrived clearly and precisely. From Gibraltar the ship proceeded to Cagliari, and thence to Spezia. Between these last two places three messages were received at sea from Poldhu, of which every word was perfectly written upon the tape of the Morse machine. The three messages ran thus. The first, from the Italian Embassy in London to the King of Italy—"Your Majesty's Embassy sends by Marconi's telegraph humblest homage;" the second, addressed to Admiral Mirabello—"The directors of Marconi's Wireless Telegraph Company beg your Excellency to forward their humblest and respectful greetings to his Majesty the King on the occasion of the transmission of the first wireless telegraph message from England to Italy. Poldhu Station;" thirdly, a similar telegram addressed to the Italian Minister of Marine. These three messages were transmitted without a fault to the Mediterranean, off the coast of Italy, across the Continent of Europe from the end of Cornwall.

As Lieutenant Solari says in his report, "such glorious results need no comment." Given these facts, however, he adds the following important considerations that are suggested by them :—

"(1) There is no distance limit to the propulsion of electric waves over the surface of the globe, both sea and land, provided that the energy of the transmission is proportioned to the distance to be covered. (2) Land interposed between the transmitting and receiving stations does not interrupt their communications. (3) The light of the sun has the effect of diminishing the field of radiation of electric waves, and therefore renders necessary the employment of greater energy during the day than during the night. The influence, also, of atmospheric electric disturbances makes it necessary to diminish the sensibility of the apparatuses so as to make them independent of it, and at the same time calls for an increase in the energy of transmission so as to obtain the same results upon the less sensitive apparatuses. (4) The efficiency of the magnetic detector has been shown by positive experience to be superior to that of any kind of coherer, and that not only by its not requiring any regulation, but also by the absolute accuracy of its working and the great handiness and sensitiveness of the system."

With regard to the effect of light upon electric waves, Signor Marconi carried out some interesting experiments last February, the results of which were given in a paper read before the Royal Society on June 12th, entitled "A Note upon the Effect of Daylight upon the Propagation of Electro-Magnetic Impulses over Long Distance."

*STATISTICS CONCERNING THE TRAINING OF CHEMISTS EMPLOYED IN ENGLISH CHEMICAL INDUSTRIES.**

The Committee decided that the best method of obtaining the desired statistics concerning the training of the chemists employed in English chemical industries was to send a circular-letter, with a form for reply enclosed, to all those members of the Society of Chemical Industry who, so far as could be judged from the designations given in the list of members, occupy a position as manager or chemist in a works. This method was adopted because the great majority of the chemists engaged in technological work in this country are members of that Society, and because no other means of obtaining the information seemed practicable. The result of the inquiry was that more than half of those addressed sent replies to the circular. It is probable that a considerable proportion of those who did not reply are not engaged in chemical works, and therefore the following statistics may be considered to give a fair idea of the present position.

Information concerning their course of training was received from 502 managers and chemists employed in English chemical industries, Of these, 107, or 21 per cent., are graduates, and 395 have not taken a degree; 111, or 22 per cent., are Fellows or Associates of the Institute of Chemistry.

The following figures give more detailed information :—

Number of graduates of a British University	59
Number of graduates of both a British and a foreign University	16
Number of graduates of a foreign University, thirteen of whom studied also in a British University or Technical College	32
	107

Number of non-graduates trained in a British University or University College, twenty of whom studied also in a foreign University or Technical College	137
Number of non-graduates trained in a British Technical College	165
Number of non-graduates trained in a foreign University or Technical College	8
Number of non-graduates trained in Evening Classes, analysts' laboratories, works' laboratories, or otherwise	85
	395

General Notes.

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Exhibition of Industrial Appliances of Alcohol.—An international exhibition of the industrial appliances of alcohol is to be held at Lima, Peru. The date of opening originally fixed was November 1st, but this has been postponed until January 10th, 1903.

Artesian Wells.—In aid of agricultural development the Cape Colony Government have had about 2,500 artesian wells drilled during the last 12 years. About three-fourths of these were successful in striking water, usually at depths of 50 feet to 500 feet. These wells supply from each 1,000 to 50,000 gallons per day, the supply being raised by deep well pumps. Most of the holes have been put down with diamond drills.

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* Report of a Committee, consisting of Professor W. H. Perkin (Chairman), Professor H. E. Armstrong, Mr. G. T. Beilby, and Professor G. G. Henderson (Secretary). Read before Section B, British Association, Belfast.

Journal of the Society of Arts,

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FRIDAY, OCTOBER 24, 1902.

All communications for the Society should be addressed the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES ON JEWELLERY.

Mr. Cyril Davenport's "Cantor Lectures on the History of Personal Jewellery from Prehistoric Times" have been reprinted from the *Journal*, and the pamphlet (price 1s.) can be obtained on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately and are still on sale, can be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

GLASS FOR OPTICAL PURPOSES.*

By Richard T. Glazebrook, M.A., D.Sc., F.R.S.

Lecture II.—Delivered April 21, 1902.

I am to speak to you to-night about the microscope, and I should perhaps say at the commencement that I do not propose to give any complete theory of the microscope or any very full account of its action in all points, but mainly to call your attention to the defects, and the way in which they are cured or improved, chiefly by means of the use of glass of varying refrangibility and lenses of different curvatures. Now the simplest forms of microscope is of course a simple convex lens, and, theoretically, by making the lens of sufficiently short focus, and placing our object sufficiently near to the lens we may obtain whatever magnification we please. In practice, of course, there is a limit imposed on this, partly through faults of the lens and other considerations—the difficulty in making the lens very small and getting the object illuminated close to it, &c. Suppose for a moment that I call f the focal length of the lens, and d the least distance of distinct vision. Then the ordinary expression of the magnifying power of such a lens is $M = 1 + d/f$ where we suppose the eye of the observer to be placed close to the lens. However, suppose the eye of the observer is placed at a little distance behind the lens—at the secondary principal focus of the lens—then the magnifying power, instead of being $1 + d/f$ is equal to d/f. Now let us consider what happens if, instead of using one simple convex lens, we split that convex lens into two, and arrange the two some distance apart. If we suppose that the focal lengths of the two lenses we are using are f_1 and f_2, and that Δ is the distance between the principal foci of the two lenses, we can show without very much difficulty that these two convex lenses at a distance apart, are equivalent to a single convex lens, and that the focal length of that single convex lens is given by the expression $f_1 f_2/\Delta$; and the magnifying power of that simple combination, being equal to d/f, will come to $d\Delta/f_1 f_2$. Now it follows of course from this expression that by reducing the focal length of our lens we can get a large magnifying power. Clearly if you make Δ considerable, then it is possible to get out of two lenses of appreciable focal length a single equivalent lens of much shorter focal length. If you take two lenses of focal length $f_1 = f_2 = 10$ mm., and if you put these two lenses at a distance of 100 mm. apart, then the equivalent focal length of that combination of lenses comes to be 10 multiplied by 10, divided by 100 or unity. So, out of two lenses, each of a focal length equal to one centimetre you have made an equivalent lens only one mm. in focal length by placing those two lenses 10 centimetres apart; that is to say, you are able to get practically a convex lens of one mm. focal length, out of two very manageable lenses to work with. And that result really lies at the basis of the magnifying power, and the effectiveness of the compound microscope. The compound microscope, as you know, in a simple form consists of two convex lenses placed at a certain distance apart. I will, in a few moments, throw on the screen a figure of a compound microscope, and trace the light through it. There is one point, however, to notice here. You can write the magnifying power of the compound microscope, d/f, or as we have seen $\Delta d/f_1 f_3$. Now if you call f_1, the focal length of the object glass of the microscope, the first lens of the two, d/f_1, is the magnifying power of the object glass, while Δ/f_2 is the ratio in which that magnifying power is multiplied, owing to the fact that your microscope has a tube, and that you have a second lens at a distance Δ behind the first; we shall find it useful to refer to this later on in the lecture, and consider how the magnifying power of the microscope wlth which we are going to deal depends partly on the focal length of the lenses, and partly upon the distance between them.

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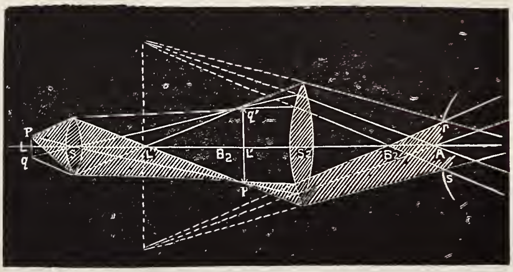
* The blocks illustrating these lectures have been kindly lent by the Editor of *The Optician and Photographic Trades Review.*

As to the history of the microscope, it would take us some time to deal with that. The earliest microscopes were probably discovered by a Dutchman named Yanssen, in Middelburg, about the year 1590, and it seems probable that he used a rather different construction from the one figured. Fontana, in 1646, I believe, was one of the first to use the simple construction shown on the screen (Fig. 26). Hooke, in 1665, improved the construction by adding another lens to the eyepiece, and making it a compound eyepiece, in this manner he got a larger field than was possible previously. With regard to Hooke, you will find in Mr. Mayall's Cantor lectures—(which were given here in 1886 and 1888), a very full historical account of his microscope, and some very interesting facts. Hooke published his results in a book called "Micrographia," and that volume is illustrated by a number of woodcuts showing what Hooke saw under the microscope. Achromatism was introduced into the lenses of a microscope, theoretically, by Martin, somewhere about 1760, and practically I think by Van Deyl, Fraunhofer, and Amici.

FIG. 26.



Let us now consider what will be the defects of an arrangement such as that shown on the slide, Fig. 26, and let us take the object glass first, First of all the object glass must be free from spherical aberration. All rays of light starting from a point L, and falling on the object glass must be made by it to converge accurately to L'.

Secondly, the condition of equal magnification for different zones of the object glass must hold good—the condition that I referred to at the last lecture, the sine law,—the condition, that, if you take a point q, near the axis, and if you consider the image of q formed by the central portion of the object glass, by s' you will get that image formed at q'. If you consider the image formed by the upper portion of the object glass, it will not necessarily be at q' unless this condition is satisfied.

If we call U the angle, which the incident ray of light, coming from L, makes with the axis, and if we call U' the angle which the refracted light makes with the axis, then the relation as it was stated at the last lecture, which must be satisfied, is that $\sin U/\sin U'$ should be a constant for all the rays. As a matter of fact, I can put that relation, and I want it, in a slightly different form—a more complete statement of the relation is that $\mu \sin U/\mu' \sin U'$ is a constant, μ being the refractive index of the medium in which the object is and μ' the refractive index of the medium in which the image is.

Thirdly, the images formed by rays of different colours must coincide on the axis; the object glass must be achromatic.

Fourthly, at the same time there must be no spherical aberration for any colour. I said at the start that there must be no spherical aberration; this must hold not only for any one ray—red or violet or blue—but also for each colour—red and violet and blue.

Fifthly, the magnification produced by the object glass must be the same for all colours. If those conditions are satisfied, then, if we have a small image p L q, and if that object is illuminated with white light, we shall get a perfect image also white.

That image has to be viewed through the eyepiece. When viewed through the eyepiece the image must not be distorted. The image must also be free from astigmatism. Astigmatism does not come in very much in the case of the object glass, because the axis of the pencil is incident very nearly directly on the object glass. The rays are incident obliquely on the eyepiece, and astigmatism may come in to a greater extent. And in addition, the focal lengths of the eyepiece must be the same for rays of different colours, in order that we may get formed a white virtual image of the white object. We have therefore to satisfy all those conditions.

Now we notice that on the object glass the incidence of the axis of the pencil is, as I have said, very nearly direct. But the pencil of rays of light that fall on the object glass is a wide one—there are a large number of rays falling on the object glass at a wide angle with each other—if we trace those rays through the object glass we see that the effect is to change them into a pencil of rays of a comparatively narrow angle. But that pencil of narrow angle is incident on the eyepiece obliquely and not at the centre of the eyepiece. The incident rays fill up the whole object glass, and are incident centrally on the object glass. These same rays may only take up an edge—a corner, as it were, of the eyepiece. These two distinctions then have to be borne carefully in mind.

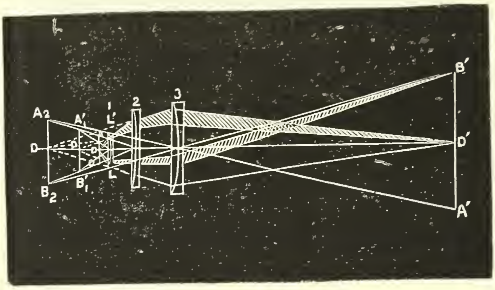
There is one other point in dealing with the corrections to which I should like to refer before I pass on to explain how these corrections are made. It is really to give you a definition—I will not attempt at present to prove reasons for the definition, which is as follows:—If you take the quantity $a = \mu \sin \text{U}$ where μ and U have the meanings already assigned, then that quantity is known as the numerical aperture of the microscope. And when I refer to the numerical aperture of the microscope, what I mean is this quantity $\mu \sin \text{U}$.

Now how are these various defects to be corrected? Let us take them in order:—Spherical aberration—a pencil of widely divergent rays—is to be transformed into one of convergent rays, having a comparatively small angle of convergence. The actual amount of refraction produced in Fig. 26 at the edge of the lens is very great indeed; and, as a matter of fact, if we were to try to get the magnification of a modern microscope with a couple of lenses we could not really do it, the actual refraction would be much greater than what is shown in the figure. And it would be impossible to correct such a lens for spherical aberration.

The first advance that was made with the object of correcting spherical aberration was to divide an object glass into a series of lenses as in Fig 27. Each lens was supposed to be corrected for spherical aberration, and each lens was corrected for chromatic aberration. And microscopes were made for some time on these principles.

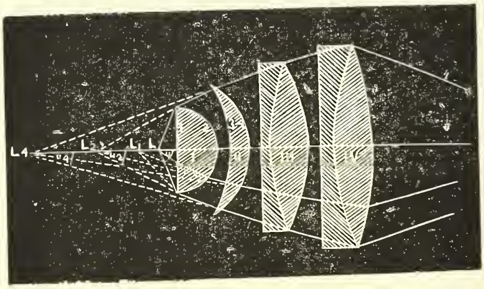
Lister was one of the first, I think, to realise that a pair of lenses such as are used in the object glass could only be made aplanatic for two points, and the method that he adopted—and that has since been adopted in the construction of the microscope—was to take a pair of lenses aplanatic for two points, and then put behind them another pair, aplanatic also for two points, making the first aplanatic point of the second pair of lenses coincide with the second point of the first pair, so that this point might be an aplanatic point for both pairs.

Fig. 27.



Now by continuing in this way the conditions for minimum spherical aberration and aplanatism were more or less perfectly satisfied. Then it was realised that there was a limit to that, that you could not make any one pair of lenses perfect or nearly perfect; and that it was much better to recognise that there must be defects in each pair of lenses; and to endeavour to correct the defects of one pair by the defects of the next pair.

Fig. 28.



In working out that principle use was made of a property of the sphere, to which I wish to call your attention. Consider then (Fig 29) a sphere of radius a, and, on the line C Q A Q', C being the centre, take two points Q, Q' such that $\text{C Q} = a/\mu$ and $\text{C Q}' = \mu a$. Then you can show that all the rays of light, whatever the angle of incidence may be, which come from Q and fall on the side of the sphere remote from Q′ will, after refraction come from Q′. If you could put an object within the lens at Q such a lens as that would be perfectly aplanatic for all rays. They would all, after leaving Q, appear to come from Q′—Q and Q′ are called the aplanatic points of this sphere. Now, of course, at first sight it is not possible to do that—it is not possible to get the object right into the lens; but suppose that instead of working with a complete sphere, you work with a hemisphere. And suppose you consider now the passage of a ray of light into that hemisphere, a ray of light coming from P, Fig. 30, would be refracted on going in, and would travel along Q R S, and appear to come from Q. It would be refracted on coming out along Q′ S T, and would appear to come from Q′. And now suppose you arrange things in such a way that if P is the source of light, the point Q may be the first aplanatic point of the sphere. Then the point Q′ will be the other aplanatic point, and there will be no spherical aberration produced by the second surface of the lens—the whole is due to the front surface of the lens. But a process such as this produces chromatic aberration in the lens. The path drawn may be the path of a red pencil of light, the violet will be more refracted. This defect constitutes what is called chromatic aberration—colour defect in the lens—and has to be corrected by another lens put on behind, as we have already seen.

Fig. 29.

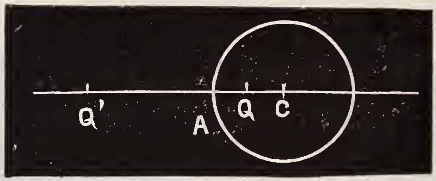
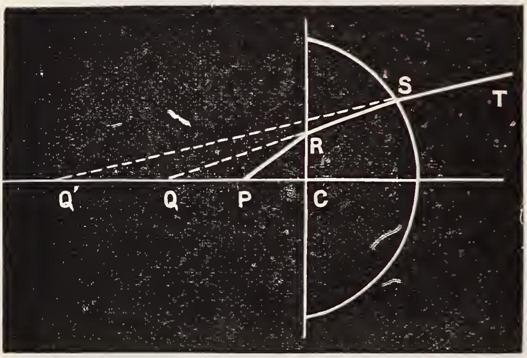


Fig. 30.



Now I have said that the aplanatism, or freedom from spherical aberration altogether, could be made very much more perfect provided you had the object within the lens. The first to recognise that was, I think, Hooke, who used hollow lenses filled with liquid, a glass sphere filled with liquid, and he suggested that if you were to place a drop of the liquid between the object and the lens, of the same refractive index as the liquid in the lens, then, practically, you had the required condition satisfied, and you got rid—the object being in a medium of the same refractive index as the lens—you got rid of the refraction at the first surface. He suggested immersion lenses, and he states very clearly in his book "by which means this liquor being of a specific refraction not much different from glass the second refraction is quite taken off" and the only refraction left is that which will give you an image free from aberration. Well, of course, that principle has been very fully recognised now, and is used with oil immersion lenses. We shall have to return to some of the advantages of homogeneous immersion shortly. Now I have said something as to the method of getting rid of the spherical aberration by the combination of a certain series of lenses, and I have called your attention to the fact that chromatic aberration or colour defects are produced by these lenses, and to the attempt made to correct that colour defect by means of other lenses.

But is that correction in any way a complete correction? and, if so, on what is the correction based? I explained in the last lecture, generally, the theory of the correction. You take lenses of two different materials, ordinary crown glass and flint glass, and such that the amount of dispersion produced by the flint glass lens just balances the amount produced by the crown glass lens. If it were possible to get two glasses which had that property perfectly, so that the dispersion of one exactly balanced that of the other, then the condition for achromatism would be completely satisfied, and the image would be perfect as far as colour was concerned. We shall see, however, that it is not possible to satisfy the condition completely. You will remember that I explained that two spectra were supposed to be produced by a flint glass prism, and a crown glass prism respectively, made so as to produce spectra of the same length from the line B to the line H; but now if we consider the figure (Fig. 31) it appears that the lines in the crown glass prism are all displaced somewhat to the right, except of course the B and the H lines which are made to coincide.

The red end of the crown glass spectrum is lengthened compared with that of the flint, and the blue end is shortened. And in consequence of the fact that the two spectra which are produced by the crown glass, and the flint glass separately, are not exactly the same, you do not get perfect compensation when you superimpose the one spectrum on the other, of course reversing their directions. Perhaps an easy way of showing that is to plot the curve that you would get if you were to calculate out the focal length of a compound lens for the various colours. Suppose for example that I draw a figure as in Fig. 32, and that I represent horizontally, focal lengths, and vertically, the lines of the spectra for which the focal lengths are drawn. Then if I suppose the focal length of the lens is the same for the two lines C and F, and draw a curve such that the horizontal abscissa of any point may represent the focal length for a line of the spectrum given by the corresponding vertical ordinate of the curve, then the curve will have the form shown. For the line D the focal length will be shorter than for C and F; for A and G it will be longer.

Fig. 31.

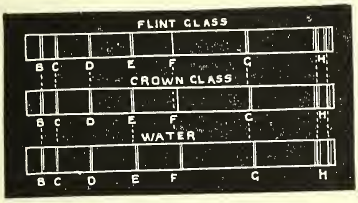
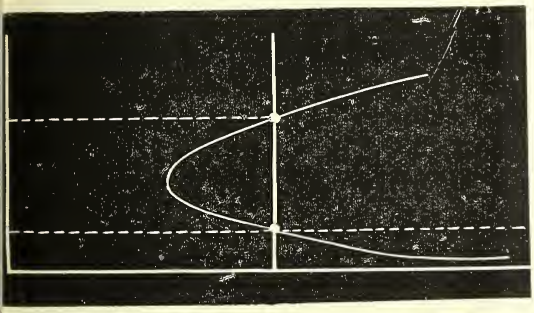


Fig. 32.



The curve which you get for ordinary flint and crown glass is something of the kind there drawn. We want somehow or other to crush up the focal lengths, so as not to have so great a difference between the focus for the red, yellow, and violet. We need either, in the flint glass, to shorten its violet spectrum, or, in the crown glass, to lengthen its violet spectrum, to make the two spectra more nearly agree. That fact has been realised for a long time. Sir Gabriel Stokes worked at it in 1862, and Mr. Vernon Harcourt attempted to make glass which should have the required property, viz., that the violet of the flint glass spectrum should be shortened, and he prepared a number of specimens of flint glass giving his results between 1862 and 1870. With a view to investigating the effect of various substances on the refractive indices and the dispersion of light, Professors Abbe and Schott began their work at Jena about the year 1882. In the first catalogue of the Jena Glass Works, they wrote: "The industrial undertaking which is here first brought before public notice has arisen out of a scientific investigation into the dependence between the optical properties and the chemical composition of solid amorphous fluxes which was commenced by the undersigned" (Schott and Abbe) "in order to discover the chemico-physical foundations of the behaviour of optical glass." And they endeavoured to find out what happened if they mixed with their glass a large number of various substances. They confirmed the discovery that salts of boron lengthen the red end of the spectrum, and shorten the blue end. They showed also in addition, that fluorine, potash and soda acted in the other direction. And they investigated the effect of lithium, barium, calcium. and aluminium. Fluorine, as we shall see shortly, was most valuable for their work, but it was very difficult—practically impossible—to mix fluorine with the glass, in retorts at any rate. Instead of clay, they had to use platinum retorts. Barium they found raised the refractive index without very greatly altering the dispersion. Glasses containing phosphates are soft, and for many purposes are not good. They may, however, sometimes be suitably used where you wish to have a small dispersion, both relatively and absolutely. Their list contains a very large number of glasses suitable for optical work. I give in the Tables statements of the optical properties of various glasses that are used now, and about which I wish to say something. Let us state first what those properties are. The first Table gives the optical properties of Messrs. Chance's glass, and the third column gives the refractive index for one definite line, the D line. The fifth column headed Δ gives the dispersion of the glass for the two lines, C to F. The value of Δ is equal to $\mu^F - \mu_C$. The fourth column gives a quantity which is known generally as ν, and is the reciprocal of what is called the dispersive power. The dispersive power is obtained by dividing $\mu_D - 1$ by Δ. The reciprocal of this is the quantity ν, so that $\nu = \Delta / \mu_D - 1$. At present there is no name recognised for ν, and someone who could invent it would be doing a real service to opticians. Then, in addition to that, we need to have the partial dispersions for the glass, that is, the ratio of the dispersion of the different parts of the glass to the dispersion of the whole spectrum, and this I have given too, in the Tables denoting them by α, β, γ.

$$\alpha = \frac{\mu_D - \mu_A}{\Delta}$$

$$\beta = \frac{\mu_F - \mu_D}{\Delta}$$

$$\gamma = \frac{\mu_A - \mu_F}{\Delta}$$

Table I. is for Messrs. Chance's glass. Table II. for the Jena glass. As a matter of fact, this column headed α' in Messrs. Chance's is not quite the same as α. It is not $(\mu_D - \mu_A) / \Delta$, but $(\mu_D - \mu_C) / \Delta$.

Well, now, if we look down these Tables, we notice that taking the first two glasses, hard crown and extra light flint, while the values of ν are very different, one being 60

I.—Table giving Optical Properties of Messrs. Chance's Glass.

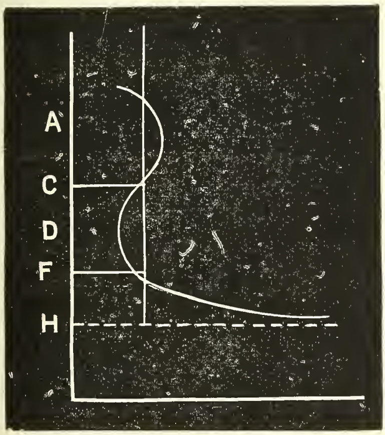
No.	Description.	μ	ν	·Δ	α'	β	γ
A 605	Hard Crown	1·5175	60·5	00856	·395	·704	·570
490	Extra Light Flint	1·5316	49·	01085	·286	·714	·585
458	Light Flint	1·5472	45·8	01196	·292	·710	·595
370	Dense Flint	1·6124	37·	01650	·290	·710	·620
337	Extra Dense Flint	1·6469	33·7	01917	·281	·718	·608
299	Double Extra Dense	1·7129	29·9	02384	·280	·720	·698
B 646	Boro Silicate Crown	1·5093	64·6	00788	·302	·700	·562
563	Baryta Crown	1·5660	56 3	01006	·295	·705	·571
468	Baryta Light Flint	1·5840	46·8	01248	·290	·708	·590

II.—Table giving Optical Properties of various Jena Glasses.

No.	Description.	μ	ν	Δ	α	β	γ
O 60	Silicate Crown	1·5179	60·2	00860	·643	·703	·566
O 43	Flint	1·6202	36·2	01709	·605	·714	·609
S 30	Barium Phosphate	1·5760	65·2	00884	·644	·703	·565
S 8	Borate Flint	1·5736	50·8	01129	·645	·704	·571
	Fluorspar	1·4338	97·4	00455	·639	·707	·563
O 225	Light Phosphate Crown	1·5159	70·	00737	·658	·698	·552
O 252	Borate Flint	1·5521	53·8	01026	·650	·703	·567
O 527	Barium Flint	1·5718	50·4	01133	·623	·709	·582
O 211	Heavy Baryta Crown	1·5726	57·5	00995	·633	·706	·571
O 1209	Heaviest Baryta Crown	1·6112	57·2	01068	·636	·705	·571
O 608	Crown of high dispersion	1·5149	54·6	00943	·631	·706	·576
O 381	Crown of high dispersion	1·5262	51·3	01026	·629	·709	·582
S 7	Borate Flint	1·6086	44·3	01375	·628	·708	·583
O 2122	Heavy Baryta Crown	1·5899	60·8	00970	·640	·704	·563
O 2071	" "	1·6098	58·8	01037	·641	·704	·569
O 2388	Telescope Crown	1·5254	61·7	00852	·641	·707	·568
O 2001	Telescope Flint	1·5211	51·8	01007	·635	·705	·573

and the other 49, and the values of the dispersion different, at the same time the values of the relative dispersions α, β, γ are also different. Thus the value of γ for the one is 570 and for the other 585. So that those two glasses, which would be glasses which you could use to make an achromatic object glass, would not make a perfect one because the relative dispersions are not sufficiently nearly equal, the numbers in the columns, α, β, γ are not sufficiently nearly the same. Now let us see what we get if we take two of the modern Jena glasses, say S 30 and S 8. Then we find that, as before, the values of ν and Δ are different, but practically the α, β, γ are very nearly the same. The values of α are 644, 645, of β 703, 704, and γ 565, 571. The distribution of the light in the spectrum is much more nearly the same in this pair of glasses than in the first pair. And we might quite possibly find a pair, *e.g.*, the last pair in Table II., which would give an even better result. Now let us see what the consequence is when making a lens of those glasses. Suppose that I draw the curve that I should get if I were to use these two glasses, S 30 and S 8, in the same way as in Fig. 32, I find that the curve instead of going off like the one first drawn comes to be of the form shown in Fig. 33. The focal length of a lens, made of these two glasses, would be much more nearly the same for the whole of the spectrum than the focal length for the compound lens, made of the first two glasses; in fact, if I actually calculate the divergence in the focal lengths for the first pair, and for the second pair, you will see what a vast difference is made by a proper choice of the glass.

FIG. 33.

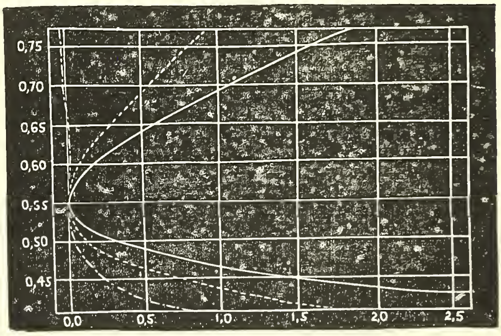


These lists of errors are calculated on the supposition that we have a lens whose focal length for the D line is 1 metre, then the errors in mm. for the various lines A′, C, D, F and G′, for the first pair of glasses, in Table II., and for the second pair, are as follows:—

	A′	C	D	F	G′
1st pair O 60 O 43	1·4	·5	0	·5	2·2
2nd pair S 30 S 8	— ·07	·07	0	·07	·5

The variations of focal length for lights of different colours are very much smaller in the case of the second than in the case of the first pair. An achromatic lens, therefore, made of the second pair, would be much more nearly perfect than if made of the first pair. The next figure shows to scale the curves which I have been drawing (Fig. 34).

FIG. 34.



Now the advantages of such an object glass are, of course, very numerous. In the first place, the image that is formed is more nearly white than that formed by a lens composed of two ordinary glasses, and, as a consequence of this, it will stand a higher magnification. But we saw, early in the lecture, that the magnification of the whole instrument might be obtained by multiplying together the magnification of the object glass and the magnification due to the tube and eyepiece, and since, with a good object glass, we may use a more powerful eyepiece, we see that either the whole instrument may be made very much more powerful if we have a very good object glass, or for the same resultant magnifying power, we can use a less powerful object glass, and, therefore, get other anvantages in the way of having a larger aperture, and more light, than we could if we were to work with a very small aperture and very high power object glass. However, there would be disadvantages, which are known to some of the practical microscope makers, in making lenses of these two glasses. To start with, the difference in the refractive indices is not quite sufficient, and the curvature of the lenses would have to be considerable in order to make the two lenses achromatic.

Now I want to call your attention to the value that is to be attached to the use of fluorspar for some of these lenses. I have in the Table the constants for fluorspar, which has a very low refractive index, 1·4338, but a very high ν, ·97. But besides that, it has almost exactly the same distribution of light in the spectrum as crown glass has. If you take for example the heavy barium crown O 1209, you find that the values for the relative dispersions are very much alike, 636, 639, 705, 707, 571, 563.

The result of that is if you make a lens consisting of fluorspar and barium crown, then you find that the distribution of light in the spectrum is even more perfect than what I have shown you there. As a matter of fact, modern lenses are often made with some fluorspar in them, not perhaps in a simple lens of two components, glass and fluorspar, but in certain cases fluorspar is placed in between two lenses of glass.

Fig. 35.

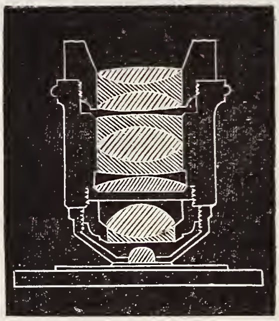


Fig. 35 shows you such a lens; for it three lines of the spectrum have the same focal length, and the lens is called apochromatic.

Thanks to the kindness of Mr. Dallmeyer, I am now able to throw on the screen some photographs by Dr. Spitta, showing the character of the work that can be obtained by modern microscope lenses of high power and the changes that take place in the surface of a lens of glass, as that lens becomes more and more fully polished.

[The lecturer then threw on the screen a series of micro-photographs of a lens surface in various stages of polish, showing the changes which take place in it as the polishing progresses.]

There are numerous other defects of lenses, of course, to speak of, and the method of curing them by the use of a proper selection of glasses, and of the proper form of the lens. I have taken the microscope lens to-night for my lecture, and have dealt with the two points, the method of correcting spherical aberration and chromatic aberration by the proper choice of materials and of shape. If I had gone on to the case of the eyepiece of the microscope I should have had to deal with oblique incidence and focal lengths, want of astigmatism, and flatness of field. These points I can treat best when dealing with the photographic lens, and that I hope to do next week.

I ought to have called your attention to one other fact. By the very great kindness of Mr. Beck, I have got here two microscopes on the table which any gentlemen who wish may examine. They are arranged to show a point that I have not yet had time to allude to, the importance of aperture on the resolving power of the microscope. These two microscopes are identical, and are arranged to view similar objects, a series of very fine lines; and they have a small diaphragm attached to them, which is so arranged that the size of the aperture is greater in one than the other. You will find that while you can see the lines distinctly in one microscope you cannot distinguish them in the other, showing that the power of the microscope to distinguish between two fine lines depends upon the aperture of the object glass, and really on that quantity which I defined as the numerical aperture, viz., $\mu \sin U$.

Miscellaneous.

*COLONISATION AND IRRIGATION IN UGANDA AND THE BRITISH EAST AFRICA PROTECTORATE.**

The paper commences with a description of the climate, and a statement of the rainfall, in the British East Africa Protectorate. A brief description is also given of the Uganda Railway, which is mentioned as a monument to the skill of its engineers, and the political and local effects of the railway are noted. Reference is made to the climatic conditions which affect Lake Victoria Nyanza, and an appendix shows the rise and fall in the surface of the lake since

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* Abstract of paper read by R. B. Buckley, C.S.I., before Section E, British Association, Belfast.

1896. The causes of the fluctuations in the lake are discussed, and it is shown that the volume of water which is actually available for storage in the lake for purposes of irrigation is not so great as might be supposed.

The Uganda Railway passes through the high lands of East Africa, where a tract of land, the size of England north of Liverpool and Sheffield, lies at an elevation of more than 5,000 feet above the sea, and has a pleasant and temperate climate. There seems to be no doubt that this country is eminently suited for colonisation, and that, if it could be irrigated, nearly all European crops and fruits could be grown in it.

The paper discusses the possibilities of irrigation in East Africa, which do not seem very hopeful. The three main rivers, the Juba, the Tana, and the Sabaki, are not well known, and their discharges at different times of the year are not recorded. The rivers are navigable in their lower reaches near the sea. It seems likely that irrigation from the Juba and Tana might be possible in the higher lands, and that 30,000 or 40,000 acres might be irrigated from the Sabaki, just below the point where the Tsavo river, which is fed from the snows of Kilimanjaro, joins the main stream. But the paper points out that the area commanded lies within the field of action of the tsetse fly, which might make cultivation difficult, if not impossible.

Reference is made to the great Taru wilderness, which has absorbed so many human lives, and the possibility of irrigating it is considered. In the tract of land, lying about 5,000 feet above the sea, through which the Uganda railway passes, there are no rivers of any magnitude; and the discharge, in the streams which do exist, is very uncertain. It is shown that the area which might be irrigated by the perennial discharge of those rivers which have a constant discharge, would be quite insignificant, and that the only way to irrigate effectively would be by the construction of reservoirs in the hills. These reservoirs would not probably be on a large scale, but would be formed by earthen banks across the valleys in which the streams run. These embankments would be, probably, at intervals in the course of a stream, and farms of moderate size would be dependent more or less on each reservoir.

The question of artesian wells is discussed, and it is pointed out that these wells would be disappointing as sources of supply for irrigation, although they might give a valuable supply of water for cattle on the great grassy plains which abound in the temperate regions.

Certain recommendations are added concerning investigations which appear necessary before colonisation, either by Europeans in the temperate tracts, or by natives of India in the less temperate areas, can be established with a good hope of success. Irrigation would, no doubt, be most valuable; but as yet it has not been proved crops can be successfully cultivated by the rainfall alone, if the cultivation is conducted with a due consideration of the local seasons.

*HOMES FOR WORKING MEN IN NEW SOUTH WALES.**

In New South Wales, under the provisions of what is known as the "Blockholders' Act," facilities have been provided to enable working men to purchase small blocks of land, and to erect suitable residences on the same. Each applicant for a block has to fill up a certain prescribed form, with particulars as to his age, occupation, and other matters; but no application can be granted to any person who does not gain a livelihood by his own labour or is under the age of 18. Each application has to be accompanied by the sum of £4 towards the first year's rent, and a survey fee of £1. Where there are several applicants for the same block a ballot is taken. This is done by making an official list of the applicants, the names being numbered in consecutive order. Marbles, with corresponding numbers, are placed in a revolving box, and the number on the first marble taken out becomes that of the successful candidate. The ballot is also used where there are several blocks applied for by a number of applicants. Each applicant for a block has to declare which block he wishes to secure, and may name several in the order of preference. The blocks are leased at certain specified rentals, and each leaseholder is required, within the first two years of his lease, to fence his land with battens or palings in accordance with the conditions laid down for his guidance. The building terms specify that no dwelling-house, shop, or warehouse shall be erected at an initial cost of less than £100, and that no material of an inferior character or likely to disfigure the general appearance of the building shall be permitted. It is also provided that a building line shall be laid down, beyond which no lessee shall be allowed to build. Arrangements have been made for supplying, free of charge, complete working drawings of a type of house deemed suitable by the State Minister for Lands, in accordance with the £100 limit of cost. Each lease is transferable, but the person to whom a lease is transferred must also be a labouring man. The working of the system will be watched with interest, as it will enable members of the labouring classes to secure healthy homes at a minimum of cost. The great drawback of ordinary building societies is the number of fees and fines which have to be paid before a borrower can secure his deeds. In a mutual society the charges outside the repayments of loans are kept at the lowest level, while in others they total up in a manner unexpected by the borrower. The facilities afforded by the "Block-holders' Act," in connection with those for co-operative settlement under certain clauses of the State Lands Act, would, if properly utilised, go far towards improving the social condition of the labouring classes in various parts of the State. The great difficulty consists in the migratory character of a large section of the population. In older countries the existence of extensive manufacturing industries causes the population to become more settled than in new or sparsely populated lands. At the present moment New South Wales furnishes exceptional inducements to persons of limited means to become the owners of their own dwellings, especially on the co-operative system, which is as yet in its infancy in Australia, save in connection with certain branches of agricultural production. If the facilities afforded by the "Block-holders' Act" are properly utilised, the labouring class portions of the New South Wales cities and townships should become as healthy and picturesque as any to be found elsewhere.

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* Communicated by Mr. John Plummer, of Sydney Australia.

THE FUTURE OF COAL MINING.

Mr. T. J. Davies, President of the South Staffordshire and East Worcestershire Institute of Mining Engineers, in his Presidential Address at the late meeting, made the following remarks on the future of coal mining:—There must be closer alliance between coal mining and industry. It is an interesting speculation whether we can double or treble the present output of coal within the present century, or may hope to reach an output of 1,000 million tons! Even that limit is not beyond the ingenuity of science. The question is whether the coal resources can stand it. There is geological evidence that the coal resources of the country are sufficient for the next 200 years if we are willing to mine to a depth of 3,000 to 4,000 feet. There is, therefore, not much cause for alarm. What is more important is the industrial problem of working deep mines. How are the geological and natural difficulties of deep mining to be surmounted? How is the natural heat of the mine to be subdued? It will be from 60° to 80° higher than at the surface, and there will also be the noxious gases to deal with. At present these difficulties make it impossible to work a mine 5,000 feet deep or more, but when the necessity arises who would say that mining science will have advanced so that the mine could be cooled down to the temperature necessary for the safety and health of the miners, and the other dangers removed. If those difficulties can be obviated the other difficulties of an engineering character could be surmounted. He ventured for a moment to pose as a seer of the future. The mine of the future would be, probably, from 5,000 to 10,000 feet below the surface; the workings would be reached by inclined drifts of 7, 8, or 10 miles in length. There would be two or three tunnels, and double lines in each would be set apart for traffic. Electric locomotives would travel up and down those tunnels drawing trains of waggons. In those extensive mines 7,000 or 8,000 men would be employed, and they would, in fact, be subterranean towns in which the workers would remain several days underground. The output would be 30,000 to 40,000 tons per day, and a large portion of the produce would be consumed in gaseous form or as electrical energy. No doubt that seemed like a mining romance, but he did not think it an extravagant assumption as to the capacity and triumph of engineering science when we have such a wonderful substruction of past experience and achievements on which to build up future success. The President terminated his address as follows:—It becomes the duty of all business men to make preparations to meet the forthcoming formidable foreign competition by adopting all the aids of science and new methods. Our geologists must assist and direct the efforts to discover our hidden treasures of coal. Our mining engineers must solve the problem of economy and reduced cost of working deep mines. There is another duty—viz., that of the Government to protect and encourage our coal export trade. He regarded the imposition last year of the tax on exported coal as a retrograde policy and detrimental to the coal mining interests of the country.

THE CHINA TEA TRADE.

The change which has come over the tea trade, not of Foochow alone, but at other producing centres in China, and which is ruining what was once a flourishing industry, seems, according to H.M. Consul at Foochow, ascribable to several causes, not all within the power of the sufferers to remedy. Firstly, there is the indisputable fact that the use of due care in the manipulation of the leaf when growing, when being picked, and when being prepared for its transit over the sea, is not exercised by the native grower. The means of ensuring all this has been repeatedly indicated to him, and put within his reach, with no result, owing either to apathy, ignorance, or dogged conservatism. He has been in turns implored, scolded, and lectured, but all to no purpose. Some years ago a circular was issued by the Inspector-General of the Customs, warning tea growers that owing to the superior methods prevailing in India, the trade was slipping out of China's hands—hands that used to supply the world. It was recognised by Europeans interested in the industry, that the lead taken by India and Ceylon has been secured by the substitution of machinery for hand labour. Machinery was accordingly imported. In some places, more even than this was done in the effort to infuse new life into a moribund industry. While Formosa was still Chinese the Governor imported into the north of the island not only the machinery considered desirable, but even an expert from Assam. But neither in Formosa, nor in Foochow, have these devices proved of any avail. To the intelligent native they possibly appealed, but not to the fountain head—the grower and picker, whose methods continued to be unscientific and primitive. His livelihood was obviously slipping from him, but the prospect of even that catastrophe has has no power to startle him from his invincible optimism. Secondly, there is the change which has come over the public taste in Europe. When China held the monopoly of tea production, China tea was necessarily bought. But when Assam and Ceylon entered into the competition, it was very soon apparent that the liking for their products was increasing rapidly, and China tea was in no long time hopelessly distanced. It is likely that as regards delicacy of flavour and aroma, the teas of China are still assured the suffrages of the cultivated few. Teas from the nearer East are, says Consul Playfair, admittedly coarser of taste, and contain a larger proportion of tannin, on which account they are condemned by medical men as prejudicial to digestion. But they make an attractive dark brew, and are economical in that a little of them goes a long way. Thirdly, the trade in Indian and Ceylon teas has been fostered by judicious advertising, to which the Foochow merchants have not resorted. Fourthly, the trade is crushed by an excessive export duty. When the duty on tea was first made specific, it no doubt represented fairly enough the 6 per cent. *ad valorem* sanctioned by treaty. The diminishing value of teas has, however, resulted in the export duty representing 40 instead of 5 per cent. The first, second, and fourth causes seem beyond the control of the merchants, but the remedy for the third should be within his reach. Advertisement is the life blood of commerce at the present day, and is freely resorted to in all departments whenever there is an element of competition. Consul Playfair says that a dozen virtues might be predicated about teas without overstepping the bounds of truth. If the teas of India or Ceylon had occupied exactly the space once filled by the teas of China the case would be more desperate. But it is not so. If China teas disappear the breakfast tables of the world will be the poorer. As regards the Indian tea industry, in the year 1901 there were 524,797 acres of land under tea cultivation in India, producing 191,250,000 pounds of tea, giving employment to some 666,000 persons, and representing an invested capital of about £10,800,000. About one-tenth of the production was in Dhera Dun, the United Provinces, the Kangra Valley in the Punjab, and Travancore district in Southern India. The other nine-tenths are grown in the provinces of Bengal and Assam. The greatest activity was in the years 1897 and 1898, when 67,000 acres were added to the tea-growing area. This tremendous expansion in the output, without any corresponding increase in the demand, bore its inevitable fruit in the glut which has in recent years brought prices down below a fair profitable level, and consequently a healthy reduction of the rate of progress set in. Last year there were only 2,284 acres added, and in the ordinary course of events a decrease in succeeding returns may be expected. The United States Consul in Bombay says that the price of tea in 1902, although higher than that of 1901, was lower than at any other time during the past thirty years. The ruling price at Calcutta during the public sale was about sevenpence a pound for broken Pekoe. The United Kingdom is still the greatest market for Indian teas, and India itself only consumes 5,500,000 pounds of home grown tea, and 3,000,000 pounds of foreign, but the consumption in the country of the home grown article is capable of considerable expansion.

THE TRADE OF THE SOMALI COAST.

There are thirty-one ports, or inhabited points, on the northern Somali coast. The most important of these, commercially speaking, is Bandar Cassem, 272 miles distant by sea from Aden. Caravans are sent from that place to the interior, supplying the tribes of the upper valleys of the Darror and Nogel; while by sea, trade is carried on by means of vessels sailing to Aden and the opposite coast of Arabia. According to the Italian Consul-General in Zanzibar, Bandar Cassem in appearance is not as attractive as some other points, the distant hills of limestone which form the background being dry and barren. A scanty line of vegetation—the green of the thorny acacias—visible in the west, marks the bed of a torrent; a branch of this stream finds its way to the village, and it is probably due to filtrations from it that the subsoil is here so rich in water—everywhere, by digging 12 or 15 feet, potable water is found—while at many of the other ports the natives are obliged to go long distances for water. The village has a population of about 800. The anchorage, which is open for large vessels, is not good; especially at certain periods of the year, when the monsoons from the north-east blows, the operations of loading and unloading are very difficult. A reef parallel with the shore, about 800 yards long, forms a channel which serves as a cover for native sailing vessels. The products of the region consist of gum, incense, myrrh, skins, native butter, cattle, and camels. It is difficult to specify the quantities, but the exports are estimated approximately at 80,000 skins of sheep and goats, 45,000 pounds of native butter, 1,000 sacks of gum (a sack contains about 136 pounds), and 8,000 sacks of incense. Gum is produced throughout the whole territory, and is of four qualities; the period of gathering is June, July, and August. The first quality of gum is the whitest and best, but it is often adulterated with gum of the second quality. The third and fourth qualities are more or less inferior, but quite distinct. The total production is estimated at 20,000 sacks, which valued at the minimum price in Aden gives 720,000 lire (£28,800). Incense—called by the Arabs and natives "luban"—is of two qualities. Luban proper, the ordinary quality is the incense used for burning. The other quality, called "maida," is finer and whiter. Its production is much more limited, and it commands at Aden double the price of luban. This quality is prized through the Orient for mastication, and also serves for various uses in industry. It is gathered during the cool season from January to April. Luban, on the contrary, is gathered in summer during the months of June, July, and August, and the more the hot south wind blows the better, and more abundant is the harvest. The total production of incense is estimated at 33,000 sacks, valued at £23,760. Mother of pearl and ambergris also figure among the articles of export, and also dried and salted fish. The total value of the export trade would probably amount to £68,560. The imports into the country are limited to articles of prime necessity, such as rice, dates, and cotton cloths coming from Bombay, Aden, and Zanzibar, and it should be borne in mind that trade in all this region is a matter of exchange. Up to the present time there has been no duty or impost of any kind. The Arabs, who taught the Somali people the method of making the palm fruitful, are authorised to cut timber for their boats. The southern part of the country is inhabited by pastoral tribes who have many horses and cattle. They, however, keep their flocks as far as possible from the forests of gum and incense-bearing trees, which constitute the greatest wealth of the country. These trees vary in height from 18 to 36 feet, growing wild not only on the mountains but in the valleys.

Obituary.

Sir Juland Danvers, K.C.S.I.—Sir Juland Danvers, who was a prominent member of the Society of Arts, died at his residence in Lexham-gardens on Saturday, 18th inst. He was elected a member of the Society in 1877, and was a member of Council from 1886 to 1889. He was also an active and valuable member of the Committee of the Indian Section. He contributed three papers to the Indian Section in 1877, 1899, and 1893, the first two being on the railways of India, and the third on the manufactures of India. He was a constant attendant at the meetings of the Indian Section, and on several occasions presided at the Ordinary Meetings. Sir Juland was the son of Mr. Frederick Dawes Danvers, formerly Secretary and Registrar of the Duchy of Lancaster, and was born in 1826. He was educated at King's College, London, and entered the home service of the East India Company as a writer in 1842, and was subsequently junior clerk; from 1848 to 1853 he was Secretary to the Chairman of the Company. In 1858 he became Assistant Secretary in the railway and electric telegraph departments, India Office, and Assistant Director of Indian Railway Companies. From 1858 to July, 1861, he was Secretary of the department and Deputy Director of Railway Companies, and in 1861 he was appointed Government Director of Indian Railway Companies, an office which he held until his retirement in 1892. He also held the office of Secretary to the Public Works Department. He was Chairman of two Indian Railways, (1) Bombay, Baroda and Central India, and (2) South Behar, and also Director of the South Indian Railway.

General Notes.

South African Locusts. — Locusts are one of the plagues of South Africa, and Mr. W. Wilcocks in his Report on Irrigation in South Africa, suggests that if all the States would combine and devote annually £20,000 each to the extermination of locusts, it should be possible to gradually exterminate this pest. "Though the area of the country is large, still it is always being traversed by Kafirs, Bushmen, shepherds, and Colonials, and the land itself is so extraordinary bare, that it should not be found very difficult to locate the locusts in their footganger stage and destroy them. Midway between Bloomfontein and Kimberley, while riding with Major Beresford, of the South African Constabulary, at the foot of some low hills in the Karoo bush, I came across great numbers of the footgangers. They were jet black, and were very easily distinguished. Indeed, it appeared as though some giant had just walked over the veld and sprinkled it with great splashes of jet black ink. If I had been a Kaffir, and had known that a reward would be given for the location of locusts in this stage, it would have been a simple matter to go to the nearest magistrate and report the appearance of the footgangers. A few men with washing soap and water and sprays could have killed many millions in a few hours. Some policy of the kind, steadily followed by all the Governments, would, of a surety, have an effect on the number of the locusts. A month later, I saw a flight of locusts near Standerton. Once the locusts had taken wing, of course nothing could be done to them, but their location, when they had settled and laid their eggs, would lead to the destruction of footgangers as soon as they had put in an appearance. In addition to the payment of rewards the State might have a paid staff of men, whose sole work would be the destruction of locusts. In ancient Egypt there must have been State *employés* of this kind, who did not, however, receive much remuneration, because, though there are scarcely any locusts in Egypt to-day, whenever a man has an ill-paid job, he says he is employed in killing locusts. It may have been the Egyptian solution of the poor white question."

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FRIDAY, OCTOBER 31, 1902.

All communications for the Society should be addressed the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

GLASS FOR OPTICAL PURPOSES.*

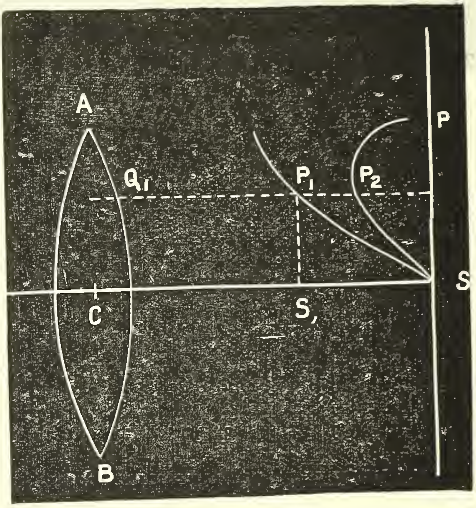
By Richard T. Glazebrook, M.A., D.Sc., F.R.S.

Lecture III.—Delivered April 28, 1902.

My subject to-night, as you are aware, is the photographic lens. There are, however, one or two matters in connection with the last lecture that I should like again to refer to. I called attention, you will remember, last time to the important place that fluorspar takes in making apochromatic lenses, because, while its refractive index is small and its total dispersive power large, it follows almost exactly the same law for the partial dispersions, viz., 639, 707, 563, as a heavy barium crown with a very much greater total dispersion. Mr. Gifford, in a paper that he read lately before the Royal Society, has investigated a curve giving the focal lengths of lenses of quartz and Iceland spar, quartz and fluorspar, and Iceland spar and fluorspar. The focal length of the lens for which this is calculated is supposed to be 27″; and over an extreme portion of the spectrum from wave length 1·9 to wave length 7·9 a lens of quartz and fluorspar is practically achromatic. I must not, however, be taken to imply that the whole improvement in the microscope which has been made in recent years is due to the chromatic corrections only. The possibility of a wider angle in the incident rays and a better field—a flatter field—has had much influence, and it is to the conditions necessary to secure a flat field that I wish to direct attention chiefly to-night.

Now, therefore, let me turn to the photographic lens. With a photographic lens the problem is different. The edge of the plate, as well as the centre of the plate—all the field—has to be well defined. Not only must the lens be aplanatic and achromatic, it should also be free from astigmatism. In addition, it should show no distortion, and the image which it is to produce is to be flat. We have already considered the aplanatic condition and the achromatic condition. As for a microscope, the aplanatic properties can be represented by two curves. If you have a lens ACB, and suppose that PS (Fig. 36) represents the plane on which the image is being formed, then the lens can be divided up into zones, as I explained in my first lecture, and you can draw two curves—one curve might possibly come like SP_1—and this curve would mean that for a point on the lens such as Q_1 the position of the image would be S_1, Q_1P_1 being parallel to the axis, and so on. And you can also draw a second curve, which would give the variation from the sine law—the law on which the size of the object as formed by different zones depends. In a good lens the image formed at SP of a distant object should be of the same size, whether it were formed by the zone near Q_1 or by any other portion of the lens. Now if we choose the shape of the lens properly, we can get rid to some extent of the defect that arises from the fact that the various zones do not always bring the image of the object to a focus at the same point, or produce an object of the same size, the defect called coma. I am going to show one or two slides

Fig. 36.



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* The blocks illustrating these lectures have been kindly lent by the Editor of *The Optician and Photographic Trades Review*.

which I also showed at the first lecture. Fig. 37 represents a lens lent by Mr. Dennis Taylor, and shows how with an oblique pencil the rays are brought to two focal lines, one of them passing through the point *c*, the other through *g*, and all the rays falling on the lens obliquely pass through these two focal lines. Now if the pencil of rays were incident at a less angle of obliquity than is shown, then the rays would be brought to two focal lines as before; but these focal lines would be nearer the axis. So that you see with a lens such as that I should not get a distinct image of an object, but I should get instead of the distinct image two focal lines formed, and the nearest approach to a distinct image would be somewhere between these two focal lines, where the section of the pencil would be more or less a circular section, as shown at *n*, though not accurately a circular section. This figure then shows the shape of a lens which is free from the defect of coma, in that the images formed by the various zones coincide, but in which the images of a distant point are two focal lines at *g* and *c* respectively, and the best image that can be formed is somewhere between the two. Figs. 38 and 39, which you will again recognise, show lenses which do produce the defect of coma. In the one case the image of a point is a pear-shaped blur with the point uppermost, in the other case it is a blur b with the point down. But in either case, an this is what I want particularly to notice t night, the best image that you can get with lens of this sort is somewhere between th focal lines, and it will be a small circular bl of light, but not actually a point of light co responding to the point source from which th rays are coming. Hence the image of a seri of points on a distant object will not be point at all, but will be these focal lines; the bes image that you can get will be blurred, an that blurred image will not lie on a plane a right angles to the axis, but it will lie on curve somewhere between the two curves tha are drawn in Fig. 37. The problem then i how to flatten this curved image so that yo can, when you put a photographic plate behind the lens, get the best image that the lens will produce formed on the photographic plate; how to throw it back as it were, and flatten it, so as to bring it on to the photographic plate. Well, there are various ways

FIG. 37.

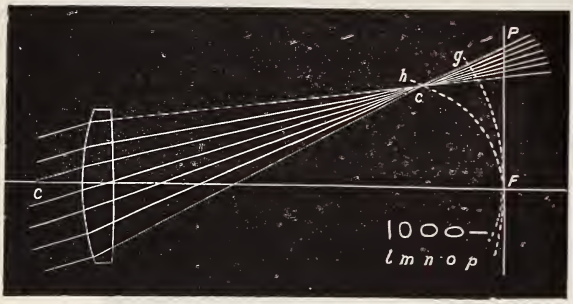


FIG. 38.

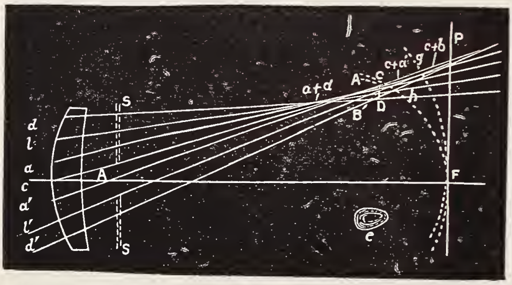


FIG. 39.

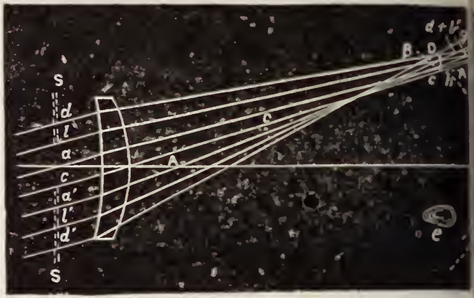
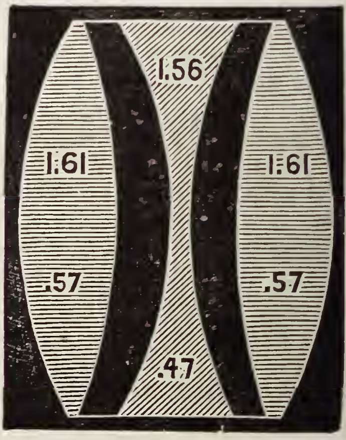


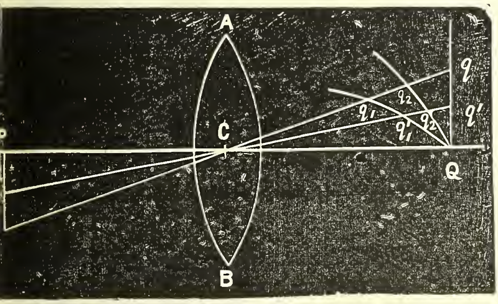
FIG. 40.



COOKE LENS.

of doing that, and I have here the figure of a lens in which it is done to a certain extent — though not so completely as is now done by the use of some of the new glasses—by the addition to the convex lens of a concave lens. This slide (Fig. 40), which I also owe to Mr. Taylor, shows how he employs a convex lens, the one shown in Fig. 40, and then, in order to flatten the field, to get over that curvature of the field of which I have spoken to you, puts behind the convex lens a concave lens, only in order to get other corrections the more easily satisfied, it is convenient to split the convex lens into two parts, and put the concave lens between them. Fig. 40 is a representation of a form of the Cooke lens, in which the flattening of the field was originally produced to a certain extent, though not completely, by means of lenses of ordinary crown glass, and ordinary flint glass between them. As a matter of fact, those glasses are not now the glasses used in the Cooke lenses; Mr. Taylor now uses, as he has told me, a dense barium crown of the Zeiss series for the concave lens; I will explain directly how the flattening of the field is produced in that case. The glasses now employed are shown in Fig. 40 in which the numbers give the values of μ and ν. I wished first of all to call attention to the older lens, as one in which the flattening of the field was to some extent produced without the new glass. Now, however, let me deal with the question a little more fully. If I take an achromatic lens A C B (Fig. 41), and consider the image that it forms of an object Pp, which is at right angles to the axis of the lens, then, as I have shown several times, the light from p falling obliquely on the lens, will be brought to two focal lines, one of which I call q_1 and the other of which I call q_2; there will be no accurate image of that point produced. Suppose now that I draw through the point Q at which the image of P is produced a line at right angles to the axis, and let the line p C$q_1\,q_2$ meet this line in q. The problem that I have to solve is so to modify the lenses as to make q_1 and q_2 coincide and form a point image coincident with this point q. And now I wish to explain to you how, to some extent at any rate, that is done. It can be done by proper choice of the material and proper choice of the forms of the lenses. I should, perhaps have said that if I were to take a point p' somewhat nearer P, the centre of the object, then the corresponding images would come to points q_1', q_2', and q', and I could get, as I have already shown you, two curves, Q$q_1'\,q_1$, and the other Q$q'_2\,q_2$, the one representing the position at which the primary focal lines would be, and the second the position at which the secondary focal lines would be. What I have to do is to bring the two curves closer together, so as to coincide with the line $Qq'\,q$. There are two defects in question. I have got to make q_1 coincide with q_2, then move q_1 and q_2 together and make them coincide with q. It might be quite possible to alter things in such a way that q_1 and q_2 should coincide, but that they should not both coincide with q. In this case then the field would be curved. I have two objects to attain, the first is to make q_1 coincide with q_2, and that makes the lens a stigmatic lens, it gives a point image at the point where the two coincide; and then I have to make the point of coincidence of q_1 and q_2 concide with q; that makes the field flat—it gets rid of the curvature.

FIG. 41.



Mr. Dallmeyer has kindly lent me a series of slides showing the difference in the action between some old lenses and some new lenses so far as astigmatism and flattening of the field are concerned.

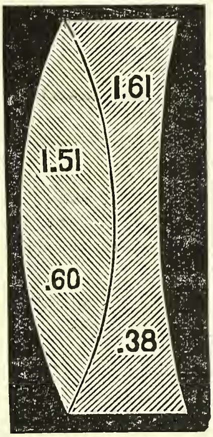
[The lecturer here illustrated the defects of astigmatism and curvature of the field by a series of slides of test objects taken with various lenses.]

I think I referred in the first lecture to Gauss's theory of lenses, and to the fact that according to Gauss's theory there are certain laws by which you can calculate exactly the position of an image formed by a lens, provided the lens behaves perfectly. Now if you try to express the action of a lens such as this which we have been discussing, which behaves very far from perfectly, you can show that the mathematical expression for the position of the image is that given by Gauss's theory together with certain additional terms which I am going to write down as S_1, S_2, S_3, S_4, S_5.

These terms are dependent upon the angle between the direction in which the light is incident and the axis of the lens; they, of course, depend also on the nature of the lens, its material, and its form. In order that Gauss's theory may hold, or rather the lens may behave as a perfect lens, which is what you want to get, these expressions—the quantities I have put down—must each separately be equal to zero; never mind for the moment what the quantities are; they depend on the distance of the screen, the distance of the object, the focal length of the lens, the material that it is made of, and so on—each term must be separately equal to zero, and if it is equal to zero then, at any rate up to the degree of exactness with which the calculations are made, the lens behaves as a perfect one. Now let the first term be made equal to zero, it can be proved mathematically that this merely expresses the condition that the lens should not show spherical aberration. If the term S_2 be put equal to zero, it can be shown that this is the condition that the sine law, as it is called, should hold, that is to say, that the magnifying power of the different zones of the lens should be the same as that of the centre. If the next term S_3 be put equal to zero then that is the condition that the primary and secondary focal lines should coincide. If the next term S_4 be equal to zero, that is the condition that the image formed should be a flat image—that the points q_1 and q_2 of Fig. 41 should not only come together, but coincide with q—while the equation $S_5 = 0$ expresses the condition that the lens should not give distortion.

The summary, however, that has just been given, does not say anything either about the aberrations or the defects due to the colour produced by refraction through the lens. In addition then, to these five conditions, we have necessarily other conditions in order that the position of the image for light of different colours should be the same,—that there should be no chromatic aberration; and then again, when dealing with the chromatic aberration we have to remember that the position of the image for the visible rays may be quite different from its position for the ultra-violet rays, which are mainly instrumental in affecting the photographic plate. We have, therefore, to consider the condition that the photographic focus of the lens, and the visual focus of the lens should coincide. Well, as I have already said it is possible, by choosing the shape of the lens, and the material of which it is made, and combining them properly, to satisfy more or less accurately the first two conditions. We spoke of these two, chiefly, at the last lecture; I have also indicated, by Mr. Taylor's figures, how it might be possible to make the term S_3 vanish and to get q_1 and q_2 to coincide. But now we come to the condition that S_4 should be zero—that is to say, that not only should the primary and secondary foci coincide, but the image formed should be flat. If we take the case, the simple case of two thin lenses—though I do not think, for this condition, that the lenses need be thin, if we take the case of two lenses for a moment, then it is possible to show—as was shown originally by Petzval and has been shown since by various others—most systematically by Von Seidel, to whom this theory is chiefly due,—that the condition which has to be satisfied in order that the image may be flat is given by the equation $\mu_1 f_1 + \mu_2 f_2 = 0$; f_1 being the focal length of the convex lens of the pair, and $f2$ the focal length of the concave lens of the pair. This is the condition that the image formed shall be flat, and of course the focal length f of the combination is given by the ordinary formula, $1/f = 1/f_1 + 1/f_2$, when the two lenses are close together as they are here. Now the lens has to be achromatic as well, and the condition that such a lens shall be achromatic is that $\nu_1 f_1 + \nu_2 f_2 = 0$, ν_1 and ν_2 being the quantities that appear in the table of optical quantities, and about which I spoke in the last lecture. Well, in order that the focus of the whole system may be positive—that the lens may act as a convex lens—it is necessary that f_1, the focal length of the positive lens, should be less than f_2. And, therefore, if you have these two conditions satisfied, it is clear that you must have μ_1 greater than μ_2, because if f_1 is less than f_2, in order that $\mu_1 f_1 + \mu_2 f_2$ may vanish you must have μ_1 greater than μ_2. So that, in order that the image may be flat, you must have μ_1 greater that μ_2. And in order to get an achromatic image you must have ν_1 greater than ν_2, otherwise $\nu_1 f_1 + \nu_2 f_2$ cannot vanish. Now look at the first Table in which the values of μ and ν are given, and you will notice that with all these glasses—the old glasses—as μ increases ν gets less. ν is 60, and μ is 1·51. If ν is only 33—much less than before—we find μ is 1·646. And, as a matter of fact, with all the old glasses, the ordinary glasses that were used, we find that when μ is large ν is small. You cannot therefore satisfy, with the old glasses, the conition that the lens shall be achromatic, and hat the field shall be flat. Fig 42 shows an achromatic lens. The refractive index of the convex lens is 1·51, and the value of ν is 60.

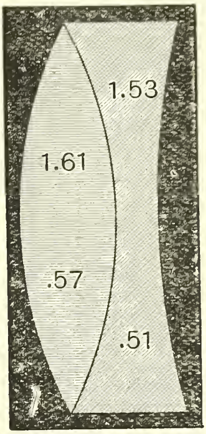
Fig. 42.



Old Achromat.

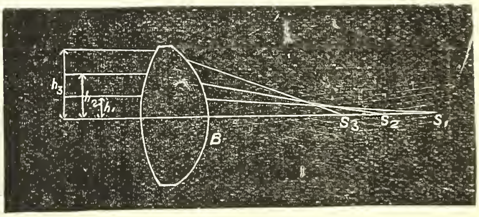
The refractive index of the concave lens is 1·61, but the ν is 38. That is an old achromat lens. Now let us turn to some of the modern glasses and look at a crown glass, which contains barium; it has been shown by Schott and Abbe that the effect of putting barium into a crown glass is to raise its refractive index without very seriously altering the value of ν, so if we take one of the barium glasses given in the Table—O 1209 for example—the refractive index has been raised to the value of 1·611. The value of ν is 57·2 for that glass. Now let us combine with that barium glass a flint glass in which the refractive index is 1·53—less than that of the barium crown, while the value of ν for the flint glass is 51 as against 57 for the crown. Such a combination is shown in Fig. 43. Thus by combining together glasses such as these you see you could get μ_1 for the Barium—the crown glass—greater than μ_2 the refractive index of the flint glass, and you also get ν_1 greater than ν_2. With two glasses, therefore, such as these you would be able to satisfy the conditions of flatness of field and of achromatism. This combination constitutes what has been called a new achromat, which is shown in Fig. 43, in which we have a convex lens of heavy barium crown, with a refractive index of 1·61, and a ν of 57, followed by a concave lens with a refractive index of 1·53 and a ν of 51. Both the ν and μ are less for this than for the convex glass; and that shows us how we may use the heavy barium glass in order to secure flatness of field. But, and it is always the way with these things—we are helped out of one difficulty but landed in another—because it follows that in order to get the lens free from spherical aberration it is important that the refractive index of the concave lens should be greater than the refractive index of the convex. I think it is pretty simple to see why this is so if we draw the figure of an ordinary convex lens (Fig. 44). Then if the light from the central portion of the lens comes down to S_1, the light from the upper portion of the lens comes to S_3. That is the general effect, as I said in the first lecture, of a convex lens, as it was of the lens that you saw in the experiments; the upper portion, the edges of the lens, are too refractive. I want, therefore, to put a lens behind which will tend on the whole to throw the outer rays up more than it throws the central rays. And now you will see if you draw the figure, that in order that this may be the case it is desirable that the refractive index of the concave lens should be greater than the refractive index of the convex lens. So that although you can get a flat image with an achromatic

Fig. 43.



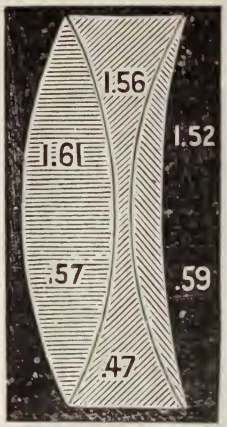
New Achromat.

Fig. 44.



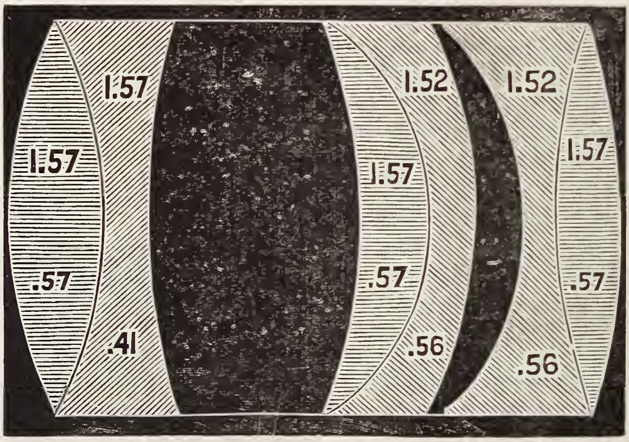
lens of the new glasses, it is difficult to get a field that is well corrected for spherical aberration, and, therefore, many of the lenses that have been made out of the new glasses combine a lens of the new glass with a lens of the old glass—the old glass lens—the old achromatic lens enables you to correct the spherical aberration in the field—I am speaking very generally—and the new achromatic lens enables you to get your field flat; by the combination of the two you can get both flatness of field and freedom from spherical aberration. A large number of the earlier lenses that were made with the new glasses were made in that way, combining together a new and an old achromatic lens, obtaining a lens of the sort required. Now it occurred to someone—I think Dr. Rudolph, but I am not quite sure—that you would then have in the centre, or at any rate that you could have, two lenses of the same glass. Why not make the two central lenses one, and allow them to do the work of the one? Thus Fig. 45 shows you such an anastigmatic lens, as it is called, made of a crown lens—convex lens—of the new crown, of index 1·61, followed by a flint lens, with index 1·56, and and then by a convex lens of the old crown, 1·52; and you will notice in this lens the refractive indices run high, medium, low; by adding on a reversed similar lens to that, you obtain a symmetical arrangement, and are able to correct to some extent the distortion, and to get the figure even more perfect than than before. Now there are various forms of lenses, some of which I have here—shown in the following figures—in which these principles are carried out. Fig. 46 is the diagrams of one of Mr. Dallmeyer's stigmatic lenses—that is, one of the first of his lenses. I think the arrangements he adopts now are somewhat different from those shown here; this was a diagram that was fully figured out in a paper that I had access to, and illustrates the principle very well. That lens consists, first of all, of a new crown glass lens of 1·57 refractive index. The crown glass is followed by a concave lens of practically the same index, but of lower value for ν. This combination is what I have described as a new achromat. It is not good alone, because the refractive index is the same for the two lenses, and a lens such as this, while it would enable you to

Fig. 45.



Anastigmat.

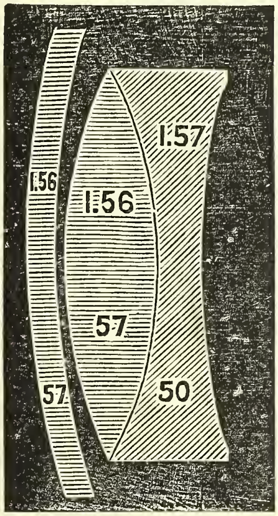
Fig. 46.



Stigmatic Lens.

correct the curvature of the field, and you could make it fairly nearly achromatic, would have considerable spherical aberration. To get over that spherical aberration, there are placed behind the crown lens two concave lenses which are shown in the figure, and the effect of those two concave lenses is to produce spherical aberration opposite in kind to the spherical aberration due to the convex lens, to enable you to complete the correction of the chromatic aberration, and also to allow you to correct or get over some of the distortion that is left in the lens; as a result you get a reasonably flat field and a remarkably close union of the primary and secondary foci, and you will also get a large quantity of light through the lens with very good definition.

Fig. 47.



Planar.

In the next figure (47) we have illustrated Zeiss's Planar lens which has something in common with the first lens in Fig. 46, and which is introduced to call your attention to another principle. Let us take as the concave lens a lens such as the second lens in this planar combination, having nearly the same index as the convex lens—the first lens has a refractive index of 1·56, and the second lens has a refractive index of 1·57—so that practically, so far as refraction is concerned, these lenses act as a single lens. We have got therefore practically a single lens, and we will consider that single lens and light of one definite colour for the moment. Then we can correct—by choosing the surfaces of the lens—to a certain extent the aberrations, the various defects, and we can make quite a reasonably good lens for one definite colour, but of course such a lens as that would show a large amount of outstanding chromatic aberration. Now among the new glasses which we owe to the Jena laboratory are several glasses that have the same refractive index but give different dispersions. For instance, in the table there are two glasses known respectively as telescope crown and telescope flint. Those two glasses have refractive indexes of 1·525 and 1·521 respectively—practically the same refractive index, but their dispersions are different. The value of ν is 62 for telescope crown, and 52 for telescope flint. So that a compound lens made of two glasses such as these would behave for the refraction of light of any definite wave length as though it were a single lens made of one kind of glass—the difference in index being so very small—but since we have made it of two different glasses which have different dispersions, we can, by choosing the common surface bounding the two lenses in a proper manner, correct for the colour defect—for the chromatic aberration. Thus suppose we have a lens which has certain properties that we want to secure, made of a glass of a refractive index such as the telescope crown—we have got a flat field, we have got a certain amount of freedom from spherical aberration and so on—and that we want in addition to correct the lens for a chromatic aberration. Now to do that, instead of making the lens entirely of this one sort of glass—telescope crown—make it of these two glasses, telescope crown and flint, which are nearly identically the same in refractive index while they are different in dispersive powers. Then it will be possible by making the common surface of a proper shape to get rid of the chromatic defect, and at the same time to leave the lens practically unaltered so far as the spherical aberration, the distortion and the flatness of the field are concerned. Now it was known that the properties of Gauss's object glass, which has the shape (shown in Fig. 49), so far as flatness of field and astigmatism were concerned, were very good, and it occurred, again I think to Dr. Rudolph, that by making the lenses of the Gauss object glass of two glasses which have practically the same refractive index, but different dispersive powers, we might correct in addition for chromatic aberration and yet retain the good properties of the Gauss object glass, so far as flatness of field and freedom from astigmatism were concerned. Thus he devised on that plan the "planar" lens, only it consists not merely of what is shown in Fig. 47, but of another portion symmetrically placed on the other side of a central stop. I think now, without dealing for the present with the question of obtaining the correction for distortion, I will pass on to the next slides which will show us certain curves. These curves (Figs. 48 to 50) are intended to show the action of certain lenses as regards their flatness of field and freedom from spherical aberration. The series of curves in Fig. 48 illustrates the spherical aberration defects and the divergence from the sine law which I explained in the early part of the lecture. The strong line curve shows the spherical aberration, the dotted line the error from the sine law. In No. 8 we have a case in which the spherical aberration and the variation from the sine law are extremely big. For the lens from which that is drawn, the focus for the central zone and the focus for the zone at the extreme end of the lens would differ greatly. In Fig. 49, No. 8 shows curves for the same lens, which give the position of the primary focal line and the secondary focal line, and you see that in this case the primary focal line and the secondary focal line differ in position greatly; No. 1 is perhaps an interesting example, because the curves are those of the original Petzval portrait lens, and you see that up to a considerable aperture the portrait lens is very fairly free from spherical aberration, but that there is very considerable curvature in the lines that indicate the positions of the primary and secondary foci, the primary line being not very far from the vertical, and the secondary line being a considerable distance to one side. Now contrast that with curves No. 11, Figs. 48 and 49, which are curves of the planar lens. You see in that case the spherical aberration is comparatively small, but the divergence from the sine law is considerable; not very large, but considerable compared with the spherical aberration; indeed, when speaking of this planar lens I should

Fig. 48.

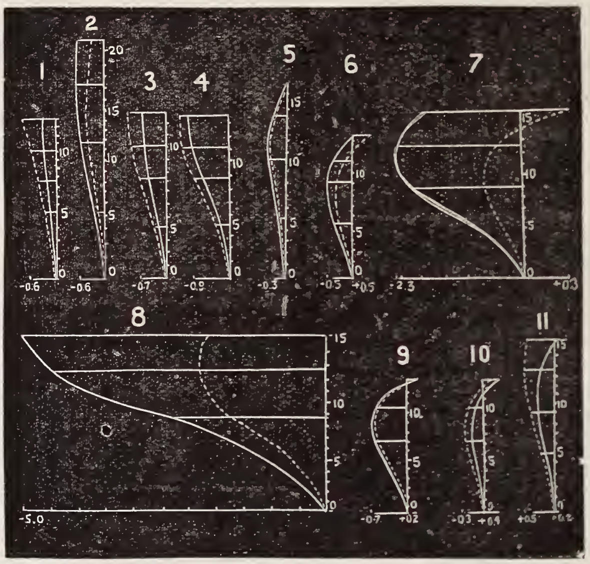
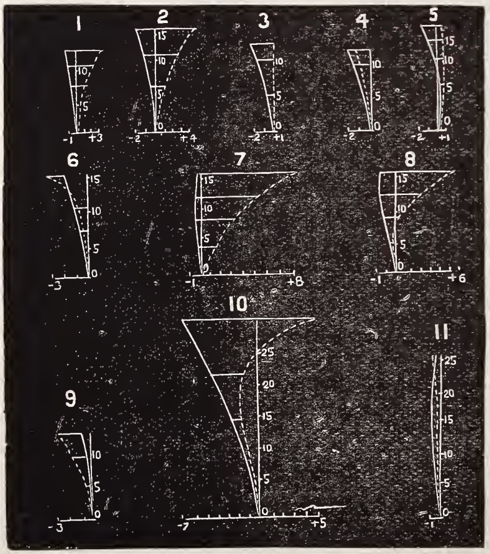
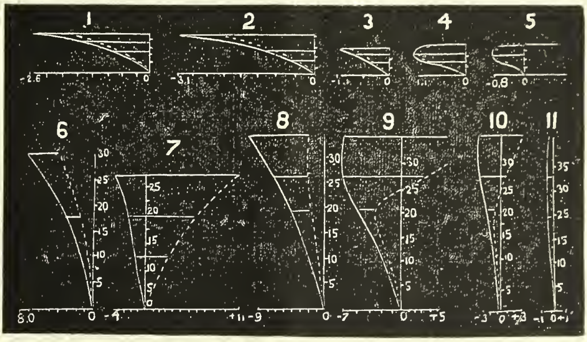


Fig. 49.



have called your attention to the fact that the single Gauss, the single planar lens, does not give you aplanatism, it does not allow you to obey the sine law properly, but by combining the two lenses and forming a symmetrical doublet, you get a closer agreement with the sine law, and this is shown by that figure. What, however, I wish to call attention to is the error of astigmatism for this lens which is shown in Fig. 49 (No. 11). You observe the two curves—the one giving the primary focal line, and the other the secondary. For the planar these are very close indeed together, showing that the errors of astigmatism have been very nearly indeed corrected. Fig. 50 again illustrates the same points for one or two other lenses. The one series shows the spherical aberration and the other the astigmatism for the lenses chosen. There is a great deal of spherical aberration, considerable variation from the sine law, and a want of flatness of the field in the first curve. That is a curve of an old French landscape glass.

FIG. 50.



[The lecturer then referred to several types of lenses, and various kinds of glass in different stages of manufacture, which he said had been kindly lent him by Mr. Dallmeyer, Professor Silvanus Thompson, Messrs. Chance, and other friends, and these could be inspected after the lecture. There were two of Dallmeyer's new anastigmatic portrait lenses —a specimen of the largest and another of the smallest types—and specimens of Messrs. Chance's glasses, light flint, hard crown, extra dense flint, soft crown. In conclusion, the lecturer said that he had been asked a question at the last lecture by a gentleman, as to the books he had used or considered useful for those interested in the subject. He had used Winkelmann's "Handbook der Physik," Müller Pouillet's "Lehrbuch der Physik," M. von Rohr "Theorie des Photographischen Objectivs," Hovestadt's "Jenaer Glas," and he had obtained a great deal of information with regard to the new glass and the apparatus for which it is used, from Dr. Lummer's "Photographic Optics," recently translated by Professor Silvanus Thompson; also on many points most valuable information was given in Mr. Dallmeyer's "Telephotography," to which he (the lecturer) would refer in his next lecture.]

Miscellaneous.

ARAB SETTLEMENTS IN AFRICA.

In connection with the question of the origin of the name Ophir, discussed by Dr. Carl Peters in his paper on Macombe's Country, and by Sir George Birdwood, in a letter where Dr. Peters's opinion is controverted (see *ante*, vol. xlviii., pp. 343, 365, 399), the following paper read by Dr. Stanley Lane Poole before the Royal Irish Academy in May last, is of special interest:—

A marble tablet, shown in an engraving, is remarkable not only as the first Arabic inscription so far discovered in Rhodesia, but as a document relating to a very early settlement of Muslims in South Africa, unrecorded in any Arabic history. Much has been published during the past ten years on the ancient monuments of Rhodesia, and the thirteen sites which formed the basis of Bent's "Ruined Cities of Mashonaland" have now been multiplied by more recent exploration till they are estimated at five hundred distinct groups of ruins, of which, however, scarcely half have even been partially surveyed, and none as yet received thorough investigation by trained archæologists. These interesting monuments, scattered over the immense stretch of country between the Zambesi and Limpopo rivers, and bearing strong points of resemblance to the remains of ancient buildings in Southern Arabia, have naturally attracted much attention, and their origin is one of the most curious problems that archæology has to solve. The hypothesis that they were the works of Sabæan miners of the period when the South African kingdoms were in the height of their power, more than fifteen hundred years before the Christian era, and that the numerous ancient gold-workings connected with these monuments were really the source of the "gold of Ophir" which the "ships of Tarshish" brought for the adornment of Solomon's Temple, as argued by Professor A. H. Keane and others, has everything in its favour, except epigraphic proof, and it may still be hoped that further exploration may reveal Himyaritic inscriptions. Nothing is more probable than that the seafaring Arabs of the Yemen and Hadramawt should have been in close commercial relations with the East Coast of Africa, and have discovered the mineral resources of Rhodesia, where numerous gold mines still testify to very ancient workings.

What the ancient Himyarites probably did in almost prehistoric times the mediæval Arabs undoubtedly carried on. There is every reason to believe that the predominant influence of Arab traders, and in some parts even of Arab rulers, was continuously maintained along the East Coast of Africa as far south at least as Beira down to the arrival of the Portuguese at the close of the 15th century. When Vasco da Gama reached Sofala, the mediæval port near Beira (towards which the ancient sites and gold routes of Rhodesia evidently converge), he found "Moorish"—*i.e.*, Arab—traders employing natives to work the gold mines, and seized Arab dhows laden with gold dust. There is no doubt that this commerce had been going on for centuries if not for some thousands of years. The references in the works of Arabic geographers and travellers, scanty and vague as they are, sufficiently prove that Sofala was well known as a port for the gold trade. El-Mas'udi, writing in the middle of the 10th century, mentions Sofala (which is itself an Arabic word, meaning "low-country") as the terminus of the voyages of the merchants of the Persian Gulf, and adds that "the country of Sofala and Wak-Wak produces quantities of gold and other marvels." El-Biruni, Ibn-Sa'id, and Yakut refer to this trade, and El-Idrisi says that in all the land of Sofala gold is found in abundance, sometimes in nuggets of a (*ratl*) pound's weight.

Probably these commercial relations between Arabia and the East Coast of Africa had been uninterruptedly maintained from ancient time; but when the Muslim Arabs first made settlements on the coast is not stated in any of the general Arabic histories. There was evidently no definite invasion at the time of the great Mohammadan expansion in the 7th century, or it would have been recorded. The only authority we possess, and that at second hand, is a "chronicle of the Kings of Quiloa," which was discovered when Francisco de Almeida, the Portuguese Viceroy, took that island in 1505. An abstract of this history—the original is apparently lost—appears in the celebrated "Da Asia" of Joao de Barros, who seems to have had the work at his disposal; and a modern Arabic MS. from Zanzibar in the British Museum (Or. 2,666) contains a brief history of Kilwa (Quiloa) which has evidently been compiled from some such earlier source as the "Chronica dos Reys de Quiloa," cited by Barros. According to this solitary authority, there were three independent settlements of Muslims on the Zanzibar coast. First a number of the schismatic sect of Zeydis—whose leader, Zeyd ibn Ali, a descendant of the prophet, was executed for proclaiming himself as the Mahdi in 740 by the Omayyad caliph Hisham—emigrated to the African coast, somewhat north of the modern Zanzibar, to escape persecution. Barros calls them "Emozaydij," which, as Mr. Arnold suggests, is probably a corruption of Umma Zeydiya, "the people of Zeyd." These were followed in the first half of the 10th century by a second (but orthodox) band of fugitives, who left their homes near the Bahreyn on the Arabian coast of the Persian Gulf in consequence of the oppression of the amir of Lasah (probably el-Hasa), and settled at the same place as the Zeydis, whom they drove into the interior. The second colony founded the great port of Makddashu (Magadaxo), which became the metropolis of the Arabs on that coast. The Morocco traveller Ibn-Batuta visited this city in 1332, and describes it as a vast town, with numerous mosques, and under the rule of a Mohammadan sultan called Sheykh Abu-Bekr ibn 'Omar. He mentions its trade with Egypt, and says that Magadaxo was fifteen days' sail from Zeyla, on the Red Sea. It was situated about half-way between Zanzibar and Bab-el-Mandbe. The third settlement of Muslims came early in the 11th century from Shiraz, in Persia. Sailing from Hurmuz in the Persian Gulf, and avoiding orthodox Magadaxo — for the newcomers belonged to the Shi'a sect—they proceeded further south to Kilwa (Quiloa), where they found a previous Muslim settlement and a mosque. Here they built a fort, and ruled until the coming of the Portuguese. This was the most important of all the Arab settlements, for the Kings of Quiloa extended their sway north over Mombasa, and south over Sofala, where they entered into relations with the native ruler, whom the Portuguese called the Monomotapa or Benomotapa, a name which Professor Keane explains as Bantu for "lord of the mines," but which the Portuguese understood as meaning merely "emperor."

Such is, in abstract, the little that we know about the Mohammadan settlements on the East Coast of Africa. Although the Quiloa chronicle places the first arrival of Muslims not earlier than 740, it is permissible to assume that other Muslims had preceded them, since it is hardly probable that a band of persecuted fugitives would have fled to an unexplored land, where the natives had the reputation of cannibals, unless some others had shown them the way. That there was some such early settlement, not only earlier than the date when the Zeydis established themselves north of Zanzibar, but also much further south, is implied by the inscription which has reached us from Rhodesia. The text, chiselled on a small slab of white marble, is quite legible.

Translation :—

In the name of God, the Compassionate, the Merciful.
There is no god but God. Mohammad is the apostle of God,
God bless and save him! And this [is] the tomb
of Sallam ibn Salah [who] had forsaken
this world for the Last Abode, and was [*i.e.* after]
the Hijra of the Prophet of the faithful five and ninety
years. The sentence ends. And God is all-knowing.
God.

We have, therefore, in this curious inscription an epitaph on a Muslim who is stated to have died in the year 95 of the Hijra, or A.D. 713-714. There is nothing whatever to suggest that it is a forgery. Its history is perfectiy straightforward. It was brought some eight or nine years ago from what appeared to be "an ancient temple" in Matabeleland—unfortunately all inquiries have failed to trace the site—to Mr. P. Hanbury France, an agent of the Union Steamship Company at Capetown. Mr. France attached no importance to it, and gave it as a curiosity to Dr. W. M. Russell, a surgeon on that line of steamers, who afterwards practised at Kimberley, and Dr. Russell passed it on to Mr. G. S. Cary, of Terenure, co. Dublin, in whose possession it remains. No one in South Africa could have forged it, nor is there any motive for forgery. Moreover, forgers follow received types, and this inscription is peculiar in many ways. Nor do I believe that it was imported. The inscription is too unusual in diction to have been composed at any educated Mohammadan centre, but its peculiarities and grammatical errors are natural in such an out-of-the-way place as Southern Rhodesia. I am told that there is no marble in Rhodesia, but this remains to be proved. Arabs do not carry tombstones about with them on their travels, nor can I imagine such an inscription entering the mind of an Arab of Arabia or a Muslim of Egypt; the language is too bizarre.

Assuming the inscription to have been engraved in Rhodesia and set up over the tomb of this Sallam, son of Salah, the question remains, Is it the original epitaph or merely a commemorative tablet erected in later times? The style of writing is no certain guide, since we possess no other specimens from the same region, and without dated examples epigraphic science cannot exist. The Arabic character varies so greatly at different places in different ages, that it would be rash to draw conclusions from similar styles of inscriptional *naskhi* elsewhere. Still, judging roughly by the character, it is impossible to believe that it goes back so far as the 8th century, and having regard to the peculiar formulas "the sentence (or record ends" and "God knows best," I incline to the belief that there was some doubt as to the actual site of the tomb of Sallam ibn Sala—possibly a local saint—and that some later Muslim put up the tablet, with all reserve, to commemorate the spot identified by local tradition. Such tablets are not uncommon in the East over the graves of holy men, and to erect them is a pious act which brings credit to the commemorator. There remains, however, the possibility that the century of the date has been omitted, but this I think improbable.

It will be seen that there are a good many problems connected with this tablet which are not easily solved. This much, however, may be laid down. If not actually a contemporary tombstone of a Muslim who died in Southern Rhodesia in the beginning of the 8th century, it shows at least that there was a local tradition in regard to such a person strong enough to induce some one in later times to set up a commemorative tablet recording his name and date. As the solitary Arabic document from South Africa the inscription is valuable; but it is to be hoped that it will not long enjoy its unique eminence. A qualified archæological exploration of Rhodesia ought to bring to light other monuments of the Muslim and possibly far earlier periods, and decide many questions in regard to the ancient and mediæval history of South Africa which can never be settled until we have the evidence of trained explorers and thorough excavation of the numerous sites which so far have been scarcely more than looked at. Such an archæological survey should be undertaken without delay, and the results should be collected in the museum of the Rhodesia Scientific Association, whose members are fully alive to the importance of the subject.

THE CANDIED FRUIT TRADE OF PROVENCE.

A particular commercial specialty in Provence is that of preserving fruit in sugar, classified in French as "fruits confits," which is carried on with greater success than anywhere else in the world. The most successful houses engaged in this business are located in the little town of Apt, in the centre of a rich and protected corner of Provence, where many kinds of fruit and vegetables are grown, and shipped to the Paris and Marseilles markets. It has been stated by one of the most prominent of the Apt manufacturers that, although he has experimented repeatedly in the United States and elsewhere with fruits of various kinds, he had failed to secure satisfactory results anywhere except in Provence. Consul-General Skinner states that this same manufacturer has a branch house in New York, where certain supplementary operations are carried on for the American trade, and he is familiar with the fruits grown in

California and Louisiana. He says that the fruits of the States mentioned, although attractive to the eye and agreeable to the taste in a fresh state, lack the consistency of the French fruits, and thus cannot be subjected to the repeated boiling and scouring which are essential to the manufacture of a translucent and perfectly finished product. This is particularly true of the cherries, from which it is difficult, if not impossible, to extract the stones without a small portion of the flesh of the cherries adhering. Even in France, the area within which satisfactory fruit for this business may be grown is restricted to the neighbourhood of Apt. Thus, for example, the apricots of Roquevaire, also in Provence, which are shipped in very large quantities in the form of pulp to important canning houses, cannot be preserved in sugar, retaining their natural form, colour, and flavour. The process of manufacture at Apt possesses no particular mystery, but is carried on with great patience under the direction of men who have inherited generations of experience. All the fruits intended for preservation in sugar, upon arrival in the factories, are placed in hermetically sealed chambers, upon shelves permitting the free passage of sulphurous flames. In this chamber about one pound of sulphur per 4,000 kilogrammes (8,800 pounds) of fruit are burned, and the chamber is kept closed for two hours. The effect of the sulphur is to brighten the fruit, give it a uniform transparency, and remove black spots and superficial imperfections. This operation terminated, the fruit is plunged into boiling water maintained at a temperature of 100° Centigrade (212° Fabrenheit), in which it remains for from twenty to sixty minutes. This operation is known as the "bleaching process," the purpose of which is to remove the last remaining natural acid and render the fruit absolutely pure. After this thorough boiling, it is removed and placed in fresh water, in order to harden the flesh, and it remains in this water, which is constantly renewed, for from twenty-four to forty-eight hours, according to the nature of the fruit. The raw material is by this time quite ready for the preserving process proper. It is first placed in boiling syrup daily for a period of about two months. There are ten different operations connected with this branch of the process, which results in the concentration of the syrup and guarantees the complete preservation of the fruit. The fruit is continued in syrup until the moment for packing and forwarding arrives, when it is removed, washed in water, and finally crystallized, an operation which consists in again plunging the fruit into syrup with boiling sugar, where it remains for ten hours. With this final sugar bath, it is considered that the fruit can be delivered with entire security to the public. It is well understood that the use of sulphur is of no importance in so far as the real merit of the finished product is concerned; but on the other hand, there is no doubt that it readers it much more attractive to the eye.

Obituary.

REV. THOMAS WILTSHIRE, M.A., D.Sc.—The Rev. Dr. Wiltshire, a life-member of the Society of Arts since 1888, died at his residence at Blackheath on Sunday, 26th inst., of heart failure. He graduated in 1850 from Trinity College, Cambridge, being placed among the senior optimes in the mathematical tripos. He devoted his studies chiefly to geological and kindred subjects, and published several geological works. He was for many years Secretary of the Palæontographical Society. In 1872 he became Lecturer in Geology at King's College, London, and assistant Professor in 1881. He was Professor of Geology and Mineralogy from 1890 to 1896, when he retired. He had been curate at several London churches, and was evening lecturer since 1865 at St. Clement's, Eastcheap. He took an active interest in the progress of technical education, and was a member of the Council of the City and Guilds of London Institute. sitting as one of the representatives of the Clothworkers' Company, of which company he was a past master.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOV. 3...Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Sir John Cockburn, "Australian Agriculture."

Engineers, in the Theatre of the United Service Institution. Whitehall, S.W., 7½ p m. Mr. T. Andrews, "Effect of Segregation on the Strength of Steel Rails."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Sir William Ramsay, "Preliminary Investigation of the Chemical Changes produced by various Reagents on Gutta-percha."

British Architects, 9, Conduit-street, W., 8 p.m. President's Opening Address.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. M. Flinders Petrie, "The Earliest Kings of Egypt."

TUESDAY, NOV. 4...Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Address by the President, Mr. J. C. Hawkshaw.

WEDNESDAY, NOV. 5...Dante Society, 45, Harley-street, W., 8 p m. Dr. A. W. Verrall, "The Christianity of Dante's Statius."

Royal Archæological Institute, 20, Hanover-square, W., 4 p m. 1. Mr. W. H. Knowles, "Blanchland Abbey, Northumberland." 2. Mr. Philip M. Johnston, "Twelfth Century Paintings, recently discovered in Claverley Church, Shropshire."

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. Ebenezer Howard "The General Engineering Scheme of Garden City."

THURSDAY, NOV. 6 ..Linnean, Burlington-house, W., 8 p.m. Mr. H. J. Elwes, "Notes on a Natural History Journey to Chile."

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 6 p m. Mr. W. H. S. Aubrey, "Daniel Defoe—Publicist and Story-Teller."

FIRDAY, NOV. 7...Geologists Association, University College, W.C., 8 p.m. Conversazione.

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No. 2,607. Vol. L.

FRIDAY, NOVEMBER 7, 1902.

All communications for the Society should be addressed the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-ninth Session will be held on Wednesday Evening, the 19th of November, when an Address by Sir William Henry Preece, K.C.B., F.R.S., Chairman of the Council, will be delivered.

Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

November 19.—Opening Address of Sir William Henry Preece, K.C.B., F.R.S., Chairman of the Council.

November 26.—"Le Tunnel du Simplon, et la nouvelle ligne de chemin de fer directe Anglo-Italienne pour l'Orient." By Dr. Gustave Goegg, Professor of Technology at the High School of Commerce, Geneva. (The paper will be in French.) Sir William H. Preece, K.C.B., F.R.S., Chairman of the Council, will preside.

December 3.—"Some Aspects of Photographic Development." By Alfred Watkins. Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., will preside.

December 10.—"French Rural Education and its Lessons for England." By Cloudesley Brereton. Lord Reay, G.C.S.I., G.C.I.E., Chairman of the London School Board, will preside.

December 17.—"The South Russian Iron Industry." By Archibald P. Head, Mem.Inst.C.E. Mr. William Egerton Hubbard will preside.

Indian Section.

December 11.—"Domestic Life in Persia." By Miss Ella C. Sykes. Earl Percy, M.P., Under Secretary of State for India, will preside.

For Meetings after Christmas :—

"Industrial Trusts." By Prof. W. Smart, LL.D. Sir Robert Giffin, K.C.B., LL.D., F.R.S., will preside.

"Oil Lighting by Incandescence." By Arthur Kitson.

"The Metric System." By A. Sonnenschein.

"The Cost of Municipal Trading." By Dixon H. Davies.

"Stage Costumes and Accessories." By Percy Macquoid.

"The Principles of Applied Art." By G. F. Bodley, R.A.

"English Silks." By Frank Warner.

"Modern Movements in Decorative Art." By Charles Holme.

"British North Borneo." By Henry Walker, Commissioner of Lands, British North Borneo.

"Three Colour Printing." By Harvey Dalziel.

"The Port of London." By Dr. B. W. Ginsburg.

Indian Section.

The meetings of this Section will take place on the following Thursday afternoons, at 4.30 o'clock :—

December 11, January 22, February 12, March 12, April 23, May 14.

Colonial Section.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 o'clock :—

January 13, February 24, March 31, May 5.

Applied Art Section.

The meetings of this Section will take place on the following Tuesdays, at 4.30 or 8 o'clock :—

January 20, February 3, 17, March 17, April 21, May 19.

Cantor Lectures.

The following courses of Cantor Lectures will be delivered on Monday Evenings, at 8 o'clock :—

Prof. Vivian B. Lewes, "The Future of Coal Gas and Allied Illuminants." Four Lectures.

Lecture I.—November 24.—The effect of the last twenty years on the manufacture of coal gas—High illuminating power *versus* low-grade gas—The methods available for the economic production of low-grade gas—The effect of temperature on carbonisation.

Lecture II.—December 1.—The dilution of coal gas by gases cheaply produced by other processes—The effect of lowering candle power on the calorific value of the gas—The photometry of low-grade gas and the conditions under which its illuminating power is best developed.

Lecture III.—December 8.—The relation of the candle-power and calorific value of gas to its use with the incandescent mantle—The incandescent mantle and the directions in which it will be improved—The probable future of coal gas.

Lecture IV.—December 15.—Lighting by oil and the advances of the past fifty years—The use of oil in incandescent mantle lighting—Vapour burners and their future—Air gas and its latest developments —The present position and future of acetylene.

Julius Hübner, "Paper Manufacture." Four Lectures.

February 2, 9, 16, 23.

Prof. J. A. Fleming, M.A., D.Sc., F.R.S., "Hertzian Wave Telegraphy in Theory and Practice." Four Lectures.

March 2, 9, 16, 23.

W. Worby Beaumont, Mem.Inst.C.E., "Mechanical Road Carriages." Four Lecures.

April 27, May 4, 11, 18.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday Evenings, December 31, 1902, and January 7, 1903, at five o'clock.

Proceedings of the Society.

CANTOR LECTURES.

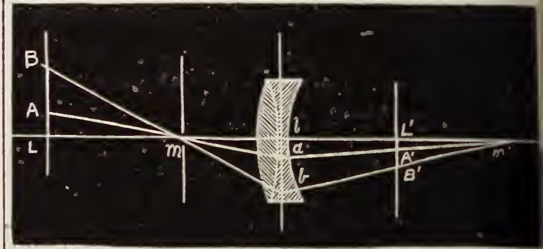
GLASS FOR OPTICAL PURPOSES.*

By Richard T. Glazebrook, M.A., D.Sc., F.R.S.

Lecture IV.—Delivered May 5, 1902.

I wish, before proceeding to the telescope lens, to say two or three words about the question of distortion in a photographic lens. I was not able to conclude the remarks I had to make on that at the last lecture. This figure (Fig. 51) is drawn to show the condition for no distortion in the image produced by a single achromatic lens. We will take, in the first instance, the case of a lens with a front stop; I shall suppose that the front stop is a very small one, and that we are only dealing at present with the axial rays of the pencils; these pass through the centre of the stop. Now let us suppose that the lens is so constructed and so corrected that all rays which pass through the point m, the centre of the front stop, after refraction by the lens also pass through the point m', which is the image of m in the lens. Let that one condition be satisfied, and further let us suppose that the incident rays, Bb, Aa, &c., meet the refracted rays, $b\,B'$, $a\,A'$ in a plane at right angles to the axis of the lens. Then it follows that the image $L'\,A'\,B'$ is exactly similar to the image $L\,A\,B$. If $L\,A$ is a certain definite fraction of $A\,B$ then it follows necessarily that $L'\,A'$ is the same fraction of $A'\,B'$—the image produced is undistorted. If it should happen that the ray corresponding to $B\,m$ did not pass through m', but that the lens were uncorrected, and the ray refracted, as it naturally would be in an uncorrected lens, so as to pass not through m' but through a point nearer to the lens than m', then it is clear that the image of B would not be at B' but at some point nearer L'—it would be drawn in towards the axis of the system too much, and the image produced would be distorted. The distortion would be of the first kind as shown at b in Fig. 19, Lecture I. But if the condition be satisfied so that m and m', the centre of the stop and its image, are aplanatic points of the lens, in which case all rays from m accurately pass through m', and if further the respective incident and refracted rays each meet in a plane, at right angles to the axis, then the lens is entirely free from distortion.

Fig. 51.



The next figure will show the case of a double lens (Fig. 52). Suppose it represents an ordinary two-lens photographic objective—a symmetrical one. The stop is usually placed in the centre between the two lenses I. and II. Let m be the position of the stop, and now let us take two rays such as those drawn passing through the stop. And let us suppose that the two corresponding incident rays accurately pass through the point m'. Then this condition is satisfied, that rays coming from the object L A B and meeting at a point m' on the axis, after refraction accurately pass the point m, midway between the two lenses, so that the first lens of the system is an aplanatic lens for the point m and its image m', for the actual stop and for what is called by Abbé the *eintritts pupille*, the entrance pupil of the system, which would be the image of the stop formed at m'. Let us suppose then that the system is accurately aplanatic for those two points, so that all rays which converge to the point m' pass through m, then, since the system is perfectly symmetrical,—the rays diverging from m and falling on the second lens of the system,—the lens II.—will accurately diverge from the point m_2 which is the image of m in the second lens. You can now see that if these conditions are satisfied, and if L′ A′ B′ is the image of L A B then L′ A′ B′, is strictly similar to L A B, that is to say, the image will be an undistorted image of the object,—the condition then that a lens of that kind consisting of two identical lenses, symmetrically arranged, should be free from distortion is that the first lens of the system shall be aplanatic with regard to the central stop, and that condition is sufficient. The figure shows that in this case the image is undistorted. I have been told that it is sometimes stated that any symmetrical lens is free from distortion. That is not by any means the case. The necessary condition to be satisfied is what I have just mentioned.

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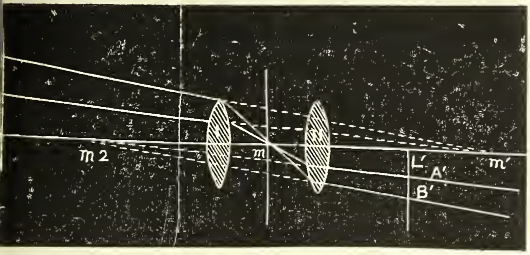
* The blocks illustrating these lectures have been kindly lent by the Editor of *The Optician and Photographic Trades Review.*

FIG. 52.

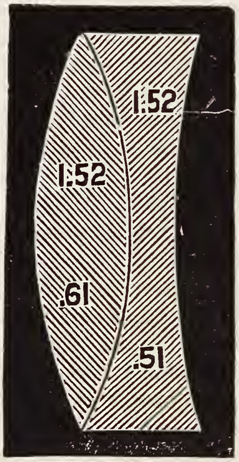


And now to pass on to what is really the subject of the lecture to-night,—Telescope lenses, and combinations of telescopic and photographic lenses. To discuss in full the various points which arise in connection with the telescope object glass would take up too much time for a course of lectures such as this, and would carry us probably into questions which are somewhat remote from optical glass, into questions of optical theory. I should have to deal with interference and diffraction of light, with the effects due to the flexure of the lenses, with defects to be anticipated in consequence of the weathering of the glass, and with many other problems. Let me recommend to those of you who are interested in the subject a little book which I have here on the "Adjustment and Testing of Telescope Objectives," which is published by Messrs. Cooke and Sons, of York. There is a great deal in that book that will be interesting to you.

For most purposes we are concerned in a telescope with a small region in the neighbourhood of the axis of the instrument. We do not deal with pencils of light that strike the axis at any considerable angle. Moreover, the incident rays from any point on the distant object practically form a parallel pencil of rays. And we have not the difficulties which arise in the case of the microscope object glass, from the wide angle of the incident pencil of rays. All the rays of the pencil will be very close together; the angle of the pencil will be small. Neither have we the difficulties that arise in the case of the photographic object glass from the fact that the pencil of rays falls on the lens obliquely, *i.e.*, at a considerable angle with the axis of the lens. The incident pencil that we are dealing with is a narrow one, and the angle of obliquity—the angle which it makes with the axis of the lens—is also a small one. Special difficulties, however, arise from the very fact that we wish to collect into the focus of the telescope a large quantity of light, and, therefore, must use a large lens, and a large lens has a large surface to be polished—special difficulties will arise from this. Then difficulties arise from changes of temperature—and from flexure. When using an astronomical telescope the change of temperature that takes place during the night causes difficulties, because of the unequal expansion of the glass of the various parts of the lens, and of the metal that holds the lens. But the main problem is to produce an aplanatic image at points near the axis of the lens, and this aplanatic image has to be also achromatic. We must remember also that in the case of the telescope we get the magnification by applying a magnifying lens to the image formed by the object glass, the whole magnification practically comes from that, and, therefore, if we are going to use a high magnifying power we need a very perfect image formed by the object glass, otherwise it would not stand the high magnification. So that the problem is to get a very perfect image of a distant object which is not far from the axis of the telescope—not far from the central line.

Now the conditions for minimum spherical aberration have been known for a long time. Gauss worked out a number of them and devised lenses, and of course lenses of various forms have been designed by numberless makers for a long period past, and very perfect many of them are. But the new glasses have rendered it possible to satisfy the condition of achromatism, that is, to get a perfectly white image of a white object to a degree which was previously thought to be impossible, and moreover they have made it possible to satisfy the conditions for an aplanatic image, for more than one colour of the spectrum. So that we can get an extremely good white image by the use of some of these new glasses. Thus, if we take these two glasses referred to in the last lecture—the telescope crown, and the telescope flint of the Jena Glass Works, the refractive indices of the two glasses are very nearly the same. We can construct a lens out of those two glasses—crown and flint—which shall satisfy the condition for minimum spherical aberration—and give us a very good image—without considering for a moment the condition to be satisfied in order to secure achromatism. Having got such a lens, which we may suppose to be a form shown in Fig. 53, then in order to get the achromatic condition satisfied, we may suppose the lens divided into two lenses along the surface shown in the figure, and then we may use the crown glass for the one lens, and the flint glass for the second lens, without having very seriously to alter the outer surfaces of the lens in order to satisfy afresh the conditions for aplanatism and for no spherical aberration.

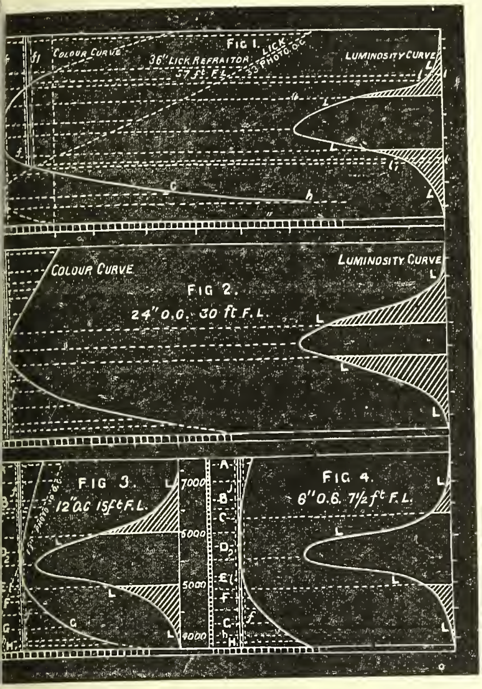
Fig. 53



But even if we take those two glasses we notice that the partial dispersions A to D, D to F, F to G, are not identically the same in the two glasses. They are 641, 635; 707, 705; 568 and 573. So that even when using those two glasses there would still be an outstanding secondary spectrum; but that outstanding secondary spectrum would not be nearly as great as in the case of the ordinary crown and flint which were used previous to the introduction of these new glasses. Still, modern astronomical research requires that the secondary spectrum should be, if possible, entirely removed. And if we are going to apply for example spectrum analyses to the image of a star, or a portion of the sun's disc, it is clearly important that the light, which must be of various refrangibilities, should be combined in the image we are going to analyse in exactly the same proportion as it is in the source itself. And, therefore, it is important that the various coloured images of the source at which you are looking which are formed by the lenses should exactly coincide, that the instrument should be perfectly achromatic. If the image formed by the object glass of the telescope is elongated in the direction of the axis of the telescope, if the violet image is at one point, and the red image at another, as it would be of course with an uncorrected lens, then clearly when you come to examine this light by means of the spectroscope, you will not get satisfactory or correct results. And as a matter of fact, in many of the great telescopes that exist this condition that the secondary spectrum should be very small is not accurately satisfied.

I think the next figure (Fig. 54), which is taken from a paper by Mr. Dennis Taylor, will illustrate that. This figure gives the colour curves for various telescopes. The first is the curve for the object glass of the great Lick Refractor, which is 3 ft. in diameter, and 57 ft. in focal length, and is made achromatic for the rays C and F, so that the focal lengths for these two rays C and F are made to coincide; the curve is drawn just in the same way as the other curves that I have shown previously. The focal lengths are measured horizontally, and the wave lengths vertically. Fig. 54, then, shows the curve giving the foci. In this figure the main divisions represent

FIG. 54.

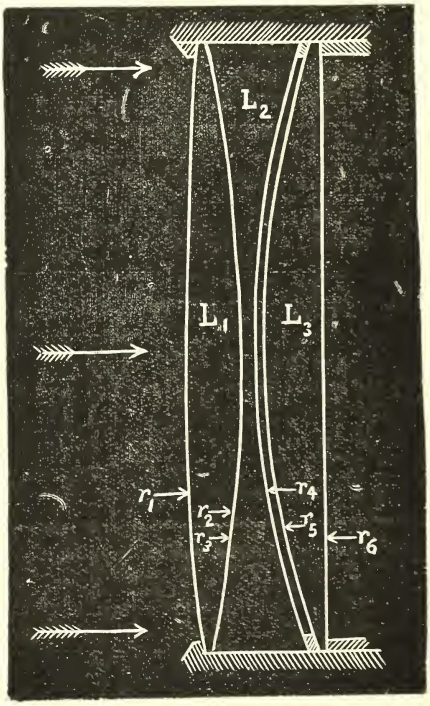


inches, and the smaller divisions represent tenths of an inch. So that you see that there is a distance of about 3 inches between the focus of the D line, and the focus of the H line. Hence if you were looking at the image of a star, and if the star sent light extending from the D line to the H line, while the image of the D line would be formed at one point on the axis, the H image would occupy a different position, and there would be 3 inches between the two points—this focal length of the lens being 57 feet. It is proportionately, of course, not a very great length, but still it is quite appreciable. The next curve is one calculated for a 24-inch object glass with a 30-feet focal length. The third is another curve for a 12-inch object glass with a focal length of 15 feet. The dotted curve is a curve calculated for some of the photographic object glasses which are now being used extensively in the photographic survey of the sky that is going on in various observatories. Those curves—I have taken them from Mr. Taylor's paper—show that there is still in some of these great object glasses a considerable amount of secondary colour correction to be overcome.

The next figure (55) shows us a lens by Mr. Taylor which appears to be remarkably free from these defects. That lens consists of three separate lenses, the first lens, L_1, is a convex lens; cemented on to it is another convex lens, L_2, and behind it is another convex lens, L_3, separated from the second lens by a small interval. I will explain the reason for that in a moment. The curvature of the front surface of the third lens is the same as the curvature of the front surface of the second lens, so that these two lenses could be made, if we wished, to come into contact—to fit in contact.

Now as to the glasses of which these lenses are made; it is of some little importance to get this clear. Taking the lenses in order, L_1 is a barium light flint. It is known in the Jena list as c·543, and its refractive index is 1·564. The value of ν for this lens is 50·6. The second lens, L_2, is a boro-silicate flint lens 0·658, its refractive index is 1·547, and its ν is 50·2. And the third lens of the system is a silicate crown glass 0·374; its refractive index is 1·511, and its ν 60·5. These are optical constants. I need not perhaps give the actual values of the radii of the surfaces. Now you will notice perhaps that the arrangement corresponds to some extent to one of the combinations—an anastigmatic photographic object glass—that I spoke of at the last lecture. The first two lenses constitute—or might constitute; I do not think the curves are quite right for that—what has been called a new achromat, in that the refractive index

FIG. 55.



falls as you pass from the first lens to the second—from the convex lens to the concave, and the value of ν also falls. The second pair of lenses constitutes an old achromat in that the change of refractive index is opposite to the change of ν—the refractive index falls from one to the other, but the ν rises, and it can be shown that it is possible, in consequence of those two conditions, to make such a system achromatic, and also to allow it to give a very fairly flat image over an appreciable distance near the axis. As a matter of fact, I am informed that for some two degrees away from the axis the image formed by such a lens is pretty nearly as good as on the axis itself. Of course two degrees away from the axis is nothing when you are dealing with photographic lenses, but with a large telescope object glass it is a very considerable angle.

MR. H. D. TAYLOR'S OBJECT GLASS.

Lens.	Material.	Number.	μ_D	ν
1	Baryta Flint	0·543	1·564	50·6
2	Boro Sil. Flint	0·658	1·547	50·2
3	Silicate Crown	0·374	1·511	60·5

Interval in Spectrum.	Relative Dispersion Convex Lenses.	Relative Dispersion Concave Lenses.
C F	1	1
A′C	0·3420	0·3425
D F	0·7059	0·7052
E F	0·2382	0·3278
F G′	0·5763	0·5757
F H_1	1·1730	1·1745

Error in millimetres from a focal length of 1 metre or various rays:—

A′	C	D	E	F	G	H_1
−0·107	0	+0·150	+0·086	0	+0·086	+0·322

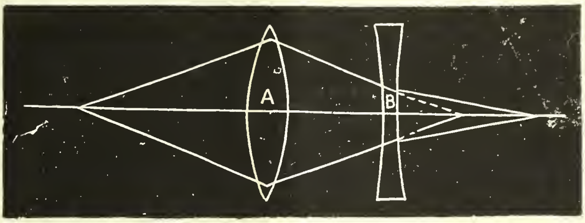
Now as to the reason for separating those two lenses. I have said it is desirable that your image should be aplanatic, not merely for the brightest colours, the yellow red or yellow green rays, but for all the colours, or for a number of colours of the spectrum. And it is found that, if you have the aplanatic condition satisfied for one colour—*e.g.*, for the red—then by altering the distance between the two lenses you can very nearly satisfy it for another colour; you can make the lens achromatic for a series of colours by being able to vary the distance between the two lenses. That was originally shown by Gauss, and is made use of in this lens of Mr. Taylor's. The latter part of the Table will show us how completely the secondary spectrum has been removed in a lens of that kind. The lens, you will remember, consists of three lenses—two convex ones, and one concave, and the condition that the secondary spectrum should be removed will be that the relative dispersion for the crown lenses, the convex lenses, should be the same as the relative dispersion for the concave lens.

Taking then the figures for the dispersions and making the total dispersion for the C and F lines the same for the two lenses, the relative dispersions work out to be for the interval A to C 3420 and 3425, for the next interval D to F 7059 and 7052. You see the series of numbers which give you the relative dispersion of the concave lens are almost exactly the same as those giving the relative dispersion of the convex lenses, and, therefore, that system of lenses is very nearly perfectly achromatic. The focal lengths for all colours are crushed up very close together. If you calculate what is the error in millimetres for a lens having a focal length of one metre, you will find that for A it is 0·10, for D it is 0·15, and so on all the way along, until you come to the line H, where the error is about three-tenth parts of a millimetre. So that in a lens having a focal length of one metre the greatest error in the position of the focus—until you come to the H line—is about a tenth of a millimetre, and when you come to the extreme H ray, it is only three-tenths of a millimetre. In an object glass of 9 feet, the error in focal length made by a difference of ·001 in the partial dispersions—a difference of twice what there is here—will make an alteration in the focus of ·02 of an inch. So that the lens is very nearly perfectly achromatised. A 12½-inch object glass on this principle has been worked at Cambridge for some time. Mr. Hinks, I understood, the last time I asked him about it, was very pleased with the lens, and I believe that Messrs. Cooke have now a large lens of the same kind in construction for South Kensington. Those of you who are specially interested in this part of our subject will find further details of other modern object glasses in the book about Jena glass by Hovestadt, to which I referred last time.

I pass over the construction, the theory and the modifications that are to be made, in consequence of the introduction of modern glass, into the field glasses and opera glasses, and glasses of that kind. But the consideration of a telescope suitable for photography leads us rather naturally or not unnaturally, I hope, to the consideration of another class of lenses suitable for photographic work in the case where the object that we wish to photograph is at a distance. I intend to say a few words about the telephoto lens, and while doing so might I recommend to any of you who are interested in it to read and study carefully Mr. Dallmeyer's book about the subject. You will find in that book a very great deal of valuable information about photographic lenses generally, and especially about the telephoto lens. I have found it of very great use personally while preparing these lectures, and I am sure that any of you who do not know the book will be interested in reading it.

Let us then take the case of a lens—an ordinary photographic lens, say, of a foot focus —rather a long focus—producing an image of an object a mile away, or, say, 5,000 feet away, in order to simplify the arithmetic a little. We have got a lens of a foot focus producing an image of an object 5,000 feet away. Well then it follows clearly enough that the size of the image on the photographic plate will only be one 5,000th part of the size of the object itself which you are photographing. It will be reduced in ratio of the focal length of the lens to the distance of the object. Hence a tower 50 feet high, if you like, would on your plate appear only 100th part of a foot high—one 5,000th part of 50 feet. It would appear about an eighth of an inch in height, and if you wanted to get an image of the tower only half an inch high you would have to use a lens which would have a focal length of somewhere between 4 and 5 feet, and the camera would need an extension of 4 or 5 feet; thus in many ways it would be extremely inconvenient and extremely difficult to work.

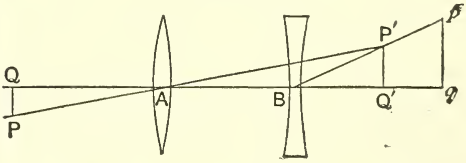
Fig. 56.



But now, suppose that we allow the rays of light, after passing through the convex lens and before they form an image of the somewhat distant object, to fall on a concave lens as shown in Fig. 56. The result of that will be that the rays which are converging together will be bent apart. The exact amount that they will be bent or refracted will depend, of course, on the curvature of the surfaces of the concave lens and its exact position, but they will in any case be bent, and it may be possible so to arrange the concave lens that these rays after passing through it will be brought to a focus at some point considerably further away. We should have formed if we were to put a photographic screen in a suitable position—an image of the distant object, and if we were to draw the figure for a point, not on the axis of the lens as I have drawn it, but at a little way off, then it would appear that the image formed on the screen will be magnified—so that we may be able to get by the introduction of a second lens in a proper position, an enlarged image of the first image—an enlarged image of the distant object—and we shall be able to get that without using a lens of great focal length, and without having a very great extension of the camera.

It may just be worth while if I prove one or two of the results that come in Mr. Dallmeyer's book which will enable us to see what the length of the extension of the camera would be for a given magnification. Suppose that we call A and B (Fig. 57) the two lenses, let the distance AB be a; let f_1 be the focal length of the first lens and f_2 the focal length of the concave lens, and suppose that we call M the magnification produced by the introduction of the concave lens, the ratio, that is to say, of the size of the second image to the size of the first image. Then if in Fig. 57 P′ Q′ is the image of the distant object PQ formed by the convex lens, and p q, the image of P′ Q′ formed by the concave lens

Fig. 57.



Since $AQ' = f_1 \qquad BQ' = f_1 - a$

Now $\frac{1}{BQ'} - \frac{1}{Bq} = \frac{1}{f_2}$

Thus $\frac{1}{Bq} = \frac{1}{f_1 - a} - \frac{1}{f_2} = \frac{f_2 - (f_1 - a)}{f_2(f_1 - a)}$

And Bq is the camera extension.

Hence the camera extension is $\frac{f_2(f_1 - a)}{f_2 - (f_1 - a)}$

While M the magnification due to the second lens is Bq / BQ'.

Hence $M = \frac{f_2}{a - (f_1 - f_2)}$

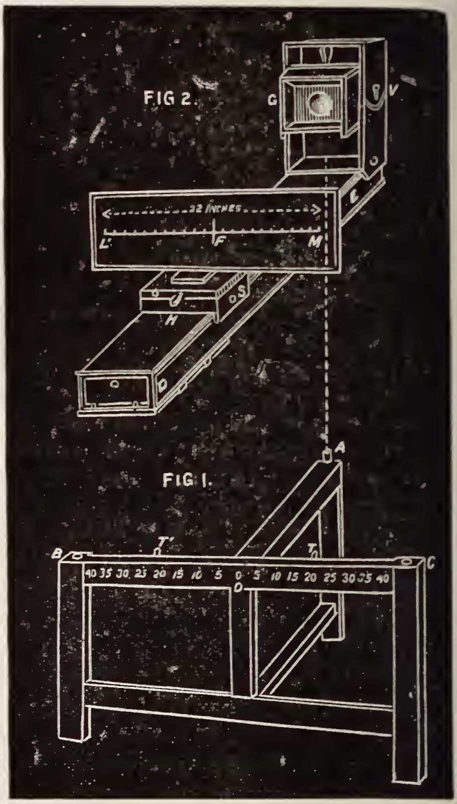
Well, suppose we take the case in which we want to make the magnification equal to four, and we choose a convex lens, having a focal length of 1 foot. Then it comes out from these formulæ that *a* must be equal to 9·75 inches, and that the camera extension must be equal to 9 inches. So that by the introduction of a concave lens which will make M equal to four, we should get the length of the camera only 9 inches, and yet we should get an image on the screen of the camera four times as big as the original image.

You will understand that in order to secure perfection of the images in an arrangement of this kind each of these two lenses must itself usually be a compound lens. You realise what a photographic lens has to do in the case of light falling on it obliquely and forming an image on the screen, and it is clear you will not get perfect images by means of two simple lenses. Those I have here on the table—some of Mr. Dallmeyer's lenses—consist, I understand, of a stigmatic lens in front and a concave lens behind it.

[The lecturer then illustrated by means of a series of slides, lent by Mr. Dallmeyer, the action of the telephoto lens.]

I now wish to pass on to the methods of testing photographic lenses, principally those which are adopted at Kew Observatory and in one or two other places. The tests that are made of photographic lenses at Kew are entirely eye tests, and the apparatus which is used has been described by Major Darwin in a paper that was read before the Royal Society some time ago. It is also very fully described in Mr. Cole's "Text-Book of Photographic Optics." Fig. 58 will show the apparatus itself, which is adopted for eye testing of photographic lenses. It is a kind of tripod table, and it has a scale along one side, and an arm at right angles to the scale running out from the centre. The scale is horizontal. There is a vertical pivot at the point A, and the upper portion, which practically forms the camera, is fixed on to the pivot A, and slides backwards and forwards along the scale. At LM there is a ground glass screen on which the pictures formed by the photographic lens are focused, and at *b* there is an arrangement for carrying the photographic objective. The objective can slide backwards and forwards in its support, and by means of this sliding motion you can bring the nodal point of emergence for the rays coming from the photographic objective exactly over the centre of the pivot A. If that is the case, and if, holding the screen fixed, you turn the lens about an axis which passes through the nodal point of emergence, then it is known that the image of the distant object formed by the lens on the screen will remain fixed. If it were formed at F originally it will still be formed at F when the lens is turned; the lens, moreover, is capable of rotation in its holder, not merely about a vertical axis passing through the nodal point of emergence, but about a horizontal axis also. You have to adjust the lens in its holder, so that these two axes do pass through the nodal point of the lens, and then

Fig. 58.



u can tilt the lens upwards or downwards ithout causing the image to move. You ave a distant object in front of the lens ; as a atter of fact, usually, in order to be able to ork at any time of day, and because the room which the lens was originally placed is not ry large, a collimator is employed. The object rdinarily used consists of four very fine lines, vo horizontal and two vertical, crossing at ght angles in the centre of the field, and that bject is placed at the principal focus of a rge convex glass. This is done very carelly so that, practically, the object is at an nfinite distance. For many purposes it would e better to have a real object at a considerble distance away, and I hope to modify the rrangemant so that this may be done ; but at resent it is not so.

KEW OBSERVATORY, RICHMOND, SURREY.

ertificate of Examination of Photographic Objective.

Class A.

. Number of objective 22974. Registered number..
. Description Anastigmat. Diameter 1¼ inches.
Maker's name...............................
. Size of plate for which the objective is to be examined 8½ inches by 6½ inches.
. Number of external reflecting surfaces 4.
. Centering in mount Excellent.
. Visible defects such as striæ, veins, feathers, &c., None.
. Flare spot None.
. Effective aperture of stops—

Number engraved on stop.	Effective aperture inches.	*f* Number.	C.I. No.*
No. 3	1·22	7·1	½
No. 4	1·14	7·5	⅔
No. 8	0·92	9·3	¾
No. 16	0·63	13·5	2
No. 32	0·46	18·5	3½
No. 64	0·30	28·5	8¼
No. 128	0·21	41·	17

* C.I. International Congress system.

10. Angle of cone of illumination, with largest stop = 74, giving a circular image on the plate of § 13 inches diameter.
Angle of cone, outside which the aperture begins to be eclipsed, with stop C.I. No. ½ = 4 giving a circular image on the plate of 0·6 inches diameter.
Diagonal of the plate = 10·7 inches, requiring a field of 63¾.
Stop C.I. No. 17 is the largest stop of which the whole opening can be seen from the whole of the plate.

11. Principal focal length = 8 6 inches. Back focus, or length from the principal focus to the nearest point on the surface of the lenses, = 7·8 inches.
12. Curvature of the field, or of the principal focal surface after focusing† the plate at its centre with largest stop movement necessary to bring it into focus for an object 2 ins. from its centre 0·01 ins. forward.
Ditto for an object 3 inches from its centre ·02 inches forward.
Ditto for an object 4 inches from its centre ·05 inches forward.
Ditto for an object 5 inches from its centre ·07 inches forward.
13. Definition at the centre with the largest stop excellent C.I. stop No. ½ gives good definition over the whole of a 8 inch by 6½ inch plate.
14. Distortion. Deflection or sag of the image of a straight line which, if there were no distortion, would run from corner to corner along the longest side of a 8½ inch by 6$\frac{5}{1}$ inch plate = 0·01 inch.‡
15. Achromatism. After focusing§ in the centre of of the field in white light, the movement necessary to bring the plate into focus in blue light (dominant wave length 4420), = 0·00 inch.* Ditto in red light (dominant wave length 6250), = 0·00 inch.*
16. Astigmatism.† Approximate diameter of disc of diffusion§ in the image of a point with C I. stop, No. ...... at ...... inches from the centre of the plate = 0· ...... inch.
17. Illumination of the field. The figures indicate relative intensity at different parts of the plate.§

	With C.I. stop No. ½.	With stop No. 17.
At the centre	100 :	Ditto.. 100
At 2½ inches from the centre.	70 :	Ditto.. 90
At 5 inches from the centre..	20 :	Ditto.. 60

General remarks. An excellent extra rapid wide angle lens, practically free from distortion.

Date of issue, March, 1902.

(Signed) W. HUGO, Observer.
(Signed) R. T. GLAZEBROOK, Director.

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§ The focus is for an infinitely distant object.

† Positive if movement towards the objective, negative if away from it.

‡ The sag or sagitta here given is considered positive if the curve is convex towards the centre of the plate.

† The objective is supposed to be perfect in other respects.

NOTE.—The following is the scale of terms used :—Excellent, good, fair, indifferent, bad.

I think, having indicated the apparatus, we may pass on to the reproduction of one of the certificates and consider how the various points mentioned in this certificate are observed. The first details are pretty obvious—the number of the objective, its description, makers' name, size of plate. The centering is tested in the usual way, by observing the images of a small point of light reflected from the various surfaces, and noting whether they be in a straight line, or whether there is any flare spot.

Section 9, effective aperture of stops, is perhaps the first point that need detain us at all. This is obtained in the following way: The lens is very carefully focused for a distant object so that the image of the distant object falls on the screen. Then, at the centre of the screen, there is placed an opaque screen with a very small hole, so as to be at the principal focus of the lens; the source of light is put behind this opaque screen; an incandescent light or some other suitable source is used, and the rays from the hole fall on the lens and emerge as a parallel penal. These rays form a circular blur on a screen on the other side of the lens, and if you measure the diameter of that blur of light it gives you practically the effective aperture of your lens for that stop. Of course if you increase the size of stop you get a wider pencil, and if you decrease the size you get a smaller pencil. And that is the way in which these numbers representing the aperture is obtained. The method of making the measurements for the next few entries is fairly simple.

The curvature of the field is obtained as follows: Suppose that the lens is focused for the distant object, and that the image of that distant object does not lie on a plane, but that the field is curved. You proceed to focus the distant object for the centre of the field. Then you have to tilt the apparatus round the vertical pivot A until light falls on the lens in an oblique direction. And you find then that unless you alter the position of the screen you do not get anything that can be called an image of the distant object. What you do then is to shift the screen and to measure the distance it moves. By doing that, for various obliquities, you get the numbers which are shown in the certificate. After focusing the plate at its centre with the largest stop, the movement necessary to bring it into focus for an object at 2″ from the centre is 0·1″, 0·2″ for 3″; 0·6″ when the image is 4″ from the centre, and 0·7 when it is 5″. So that the curvature is given in the Table.

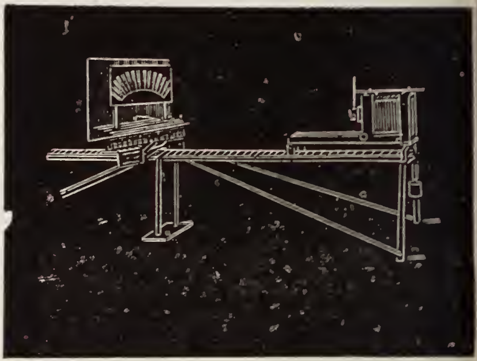
We can also get the distortion, because if the lens is free from distortion when we form the image of a straight line by light that passes obliquely through the lens the image obtained should be a straight line. But if the lens is not free from distortion the image that we obtain would be a curve. Measure the distance between the straight line and th curved line; this gives the measure o distortion.

The astigmatism of a lens is obtained b taking as the source of light the image of small flame reflected from a thermometer bulb Light refracted from a small silvered glas bulb gives you a fine spot of light. Taking then, that fine spot of light as your source, the lens is not free from astigmatism you wi get the spot drawn out in one position of you screen to a horizontal line, while for anothe position the line will be vertical. By focusin first on the vertical and then on the horizontal and finding the distance between the two lines you can get the measure of the astigmatism o the lens.

The illumination of the field at various part is obtained in a manner which is describe very fully in Mr. Darwin's paper by compariso with a standard light, varying the angle o incidence.

The next Figure (59) shows a French piec of apparatus arranged for testing a lens photographically. It is fairly clear how this works. A camera carrying the lens is placed at on end of a bench, at the other is the object which you are going to photograph. That object consists of a series of horizontal scales, or rules, and these rules are at various distances away, while a series of other rules is placed like a fan inclining down to the centre. And the marks on the rules which have to be photographed are seven circular dots. Six of these circular dots are arranged in a hexagon. The dots are all exactly the same, and there is a dot of the same size in the centre. In the standard arrangement it is designed that the reduction produced by the lens should be a reduction of one-fifth, *i.e.*, that the image should be one-fifth of the size of the object.

Fig. 59.



n this case the diameters of each of the dots s half a millimetre, and the distance between each dot is half a millimetre, thus on the plate he distance between each two consecutive dots is one-tenth of a millimetre, since the reduction is one-fifth; thus you obtain a series of dots one-tenth of a millimetre in diameter, and the distance between the various dots is also a tenth of a millimetre. Well, with a fairly good lens you will find that in certain parts of the plate these dots are clearly resolved while in other parts the resolution is less perfect. And M. Houdaille, who has designed the apparatus and used it, calls a definition of one-tenth of a millimetre a definition which will enable you clearly to resolve this series of dots, and he states that by actual measurements on the photographic plate you can see very clearly and very distinctly the limits of resolution of these dots in the various positions which they occupy; and, therefore, you are able to tell the amount of curvature of the image, because you have a series of dots at variable distances away, which are focussed on the plate, and you can also determine the astigmatic conditions, because you have your dots arranged in various orders along the fan-like arrangement. I have not worked with this apparatus, or indeed with any photographic testing apparatus; but I think it is clear that an apparatus which will test a lens in that way, a photographic lens, must be of value, and I hope before long to introduce something of that kind at our testing department at Kew, or rather at Bushy. But I should value very much suggestions or criticisms from practical people as to the best kind of tests that can be applied to photographic lenses—tests that would be of real practical aid to those who are to use the lenses.

Just this in conclusion. I have been speaking to-night principally about the telescope objective. One may now sum up the desiderata for a telescopic objective thus: You need a large value for the ratio of the two refractive powers in the two lenses. You need that the partial dispersions of the two lenses shall be as nearly as possible the same. You need also that the crown glass should have a comparatively low dispersion, and that the glass of which the two lenses are made should be permanent. Those are the objects which the maker of a telescopic lens objective glass has to aim at in his glass. He has to select his glass to satisfy these conditions. And these are the objects which the man who makes the lens has to seek to attain. When dealing with photographic lenses you want glasses having high refractive indices and high values of ν to make the convex lenses of your system. You want light crown glasses having low values of ν to make the concave lenses of your system, and you need considerable difference between the refractive powers—otherwise you have too steep curves for your lenses. You also need to have the partial dispersions in the two glasses that you are using as nearly as possible the same; and while a great deal has been done in the improvement of photographic and telescopic lenses recently, I take it there is still room for improvement before we reach perfection; these, however, are the lines along which the man who is making the glasses should work. In conclusion, I have only to thank you for the way in which you have listened to the lectures. My thanks are specially due to those gentlemen who have so kindly helped me in preparing a number of these slides, and have lent me the apparatus which has been viewed with so great interest. I have on the table again the lenses that were before you the last time, and specimens of the glass, and it may interest some of those who were not able to examine the lenses previously to see them this evening.

Miscellaneous.

THE MINING INDUSTRIES OF FRANCE.

A recent report of the Minister of Public Works to the President of the French Republic contains information regarding the coal, iron, and other mining industries of France, from which it appears that the principal French coal basin, which is in the departments of the Nord and Pas de Calais, produces 20,000,000 tons of the 33,000,000 tons mined in France annually, or about two-thirds of the total output. The extraction of coal in the Department of the Nord remains practically stationary, while the production of the mines of the Pas de Calais is increasing annually. From 1886 to 1900, the annual increase has been 650,000 tons, with every indication of its continuing. The coal basin of St. Etienne, which comes second, is much less important than the above. Its output of 400,000 tons—about 12 per cent. of the total production—does not show any marked increase. Then follow the basins of the Centre and of the Midi, which have a comparatively small output. The most important mines in these districts—those of the Gard and of the Bourgogne—produce about 2,000,000 tons each, or 6 per cent. of the total output, and they do not increase their production from year to year to any very great extent. Certain of the coal basins of France—that of Allier for example, show unmistakable signs of a still further decrease in their output, without the prospect of any improvement from new explorations.

The production of iron ore in France is centred principally in three districts, that of the north-east, or the Meurthe-et-Moselle, is the most important, producing 4,500,000 tons of the 5,500,000 tons of iron ore mined in France annually; that of the Pyrenees producing 250,000 tons, and that of Normandy, 150,000 tons; the latter may be said to be in its infancy. From its geographical position its ores are generally sent to foreign countries, while the ores produced in the other districts are consumed by the metallurgical industries of France. Of the other mines producing metallic ores may be mentioned those of the Sain Bel (Rhône), with an output of 300,000 tons of iron pyrites, and three lead and zinc mines of Molines (Gard), Sormettes (Var), and Pontpeans (Ile-et-Vilaine), producing 28,000, 20,000, and 14,000 tons respectively of merchantable products (blende and galena). The increasing demand for combustibles, the high prices prevailing and the profits earned by the mine proprietors have stimulated the researches for other coal-bearing properties. Some twenty soundings have been made to the southward of the coal basin of the Pas de Calais, some of which extend 1,000 yards below the surface. In the Gard, Saone-et-Loire, Haute Loire, and the Tarn soundings were also made, but in no case were the results encouraging. From July 1, 1899, to December 31, 1901, forty-one new concessions were granted as follows: Seven for mining coal with a surface of 7,751 acres, 17 for mining iron ore with a surface of 31,142 acres, 16 for mining other metallic ores with a surface of 36,197 acres, and one for mining salt with a surface of 4,354 acres. Of the above concessions the most important are those granted for mining ore in the Landres district, embracing over 24,000 acres of land containing ore of remarkable richness and quality; the concession for the coal mine of St. Germain (Puy de Dôme) in the new coal basin of La Boublé; the coal mine of St. Martin de Valgalgues (Gard) located upon a recently discovered prolongation of the coal basin of Alois; and the three concessions of 5,906 acres for mining iron ore in the Normandy district. Of the 1,440 concessions existing in 1899, 808 were unexploited. The latter were divided as follows: Coal mines 301, iron mines 248, other metallic ores 186, salt mines 15, and various mines 58. Of the above, 196 mines after investigation have been found to contain no veins which would produce paying results. The variation in the number of concessions from year to year is due not only to new concessions being granted, but also, in a small proportion, to the abandonment of former concessions, or to the consolidation of several concessions. Of the 178,894 workmen employed in all mines in 1900, 169,079 or 86 per cent. were engaged in mining coal and lignite. The period from 1899 to 1901 was one of the most favourable that the coal industry of France ever enjoyed. The prices went up slowly at first, but at the end of 1899 they rose rapidly until the autumn of 1900, when they commenced to fall again. The average rise was from 10 to 12 francs (8s. to 9s. 7d.) per ton of 2,200 pounds, an increase of from 30 to 120 per cent., according to the kind and quality of the coal. These prices are those for which coal for immediate delivery was sold at the mine, or for which new contracts would be made, but owing to old contracts for long periods entered into between the proprietors of mines and large consumers, the former did not receive all the benefits of the rise in price. It is estimated that the average price of coal in France during 1900 was 12s. 2d. per ton, or about four shillings above the lowest market prices of 1896 and 1897. The average price in 1901 was not materially different from that of 1900.

THE UGANDA RAILWAY.

In Commander Whitehouse's paper, "To Victoria Nyanza by the Uganda Railway," read on January 28th last (see *ante*, p. 229), it is stated that the Chief Engineer and his staff arrived at Mombasa on the 11th December, 1895, plate-laying began on the mainland on 5th August, 1896, and the first locomotive reached the lake shores on the 19th December, 1901.

A "Report by the Mombasa-Victoria (Uganda) Railway Committee on the Progress of the Works, 1901-1902" [Africa, Cd. 1080] has just been issued as a Parliamentary paper, and the following abstract is quoted from *The Times*:—

"The opening part of the report contains a statement of the progress made in the construction of the Uganda Railway during the year ended March 31, 1902. This recalls that by December 20 last year trains were running over the railway right through from Mombasa to Lake Victoria Nyanza, although construction work west of the Mau range only began on January 20, 1901. In 11 months, during five of which inclement weather prevailed, 1,679,528 cubic yards of earthworks had been excavated, and a practicable railway carried over a length of 90 miles, involving a difference in level of 4,595 feet. Port Florence (584 miles), on the Victoria Nyanza, is the lake terminus, and station buildings are now in progress there, while similar buildings, together with houses for the staff and working gangs, have been completed up to Nakuro (450 miles). Two steamers, each of 600 tons displacement, and designed and built in England, have been sent out to Africa, and it is hoped that one will be launched on the Victoria Nyanza before the end of the year. With the assent of the German Government, Commander Whitehouse, who carried out the recent survey of the British coast-line, is now engaged in surveying the southern portion of the lake. There was no fresh importation of Indian labour during 1901-1902, and large numbers of labourers have been repatriated; but it is still necessary to maintain a strong force of Indian labourers on the earthworks, and to supply them with imported food. The large body of police which the railway had maintained during the construction of the line, has since April 1 been placed under the control of the Protectorate authorities.

Part II. of the report deals with "Revenue and Open-line Working." The abstract of revenne accounts for 1901 shows a grand total of earnings of Rs. 6,041,552, and — the expenditure being Rs. 5,683,369 — a balance of net earning of Rs. 358,183. The extension of mean mileage worked in 1901 has been attended with a decrease in the receipts derived from public traffic from Rs. 48·49 per mile per week, in 1900, to Rs. 45·88 in 1901. But it is explained that any extension of the mileage falling short of a principal traffic-point—of which there are few besides the headquarters and stations—could scarcely be expected to add to the rate of earnings per mile. And not till the two steamers are launched and plying for traffic on the lake can any considerable advance in earnings be expected. The substitution of wood for coal as the locomotive fuel will ensure a great reduction in the cost of fuel during the current year. A revised goods classification, which is printed in detail in the report, gives exceptionally low downward rates, and has been received with great satisfaction by the Indian and other traders in East Africa. A fair goods traffic upwards has been attracted to the railway route from the coast to Voi for the German colony at Kilimanjaro. In conclusion, it may be added that the report contains an excellent map, and two sectional plans of the Uganda Railway, together with a number of tables illustrating the cost of the construction, maintenance, and working of the line."

Correspondence.

PHOTOGRAPHY AS APPLIED TO ILLUSTRATION AND PRINTING.

In one of the Cantor Lectures given by Mr. J. D. Geddes he describes the present methods of producing blocks by the use of the screen for trichromatic printing. Mr. Geddes mentions two methods of producing the screen negatives—the indirect and the direct. In the indirect the negatives are taken in the ordinary way, and with of course the necessary colour filters. From each of the negatives a transparency is made, and from this again a reversed negative, having the screen texture. There are thus three operations. The advantage is that the exposure for the original negatives is not lengthened as it would be by the interposition of the screen in front of the plate in the camera. There is, however, the important disadvantage of two extra operations, and a risk, not mentioned by Mr. Geddes, of deterioration of result in the screen negatives as compared with its original ones. There has been a copy of a copy of a copy for example in reproducing a painting, and although we know that skill can do a great deal in removing or modifying defects some deterioration will remain, especially in tone if not in detail.

In the direct method the required reversed negatives are made with the screen in front of the plate in the camera. This, of course, saves the two extra operations of the indirect method, but has the disadvantage of lengthening the exposure. There is also a disadvantage, not mentioned by the lecturer, of having to take three reversed negatives through colour filters in combination with either a reversing prism or mirror. The necessity of reversing is of itself a disadvantage.

In both the direct and indirect methods there is the necessity, as stated by Mr. Geddes, that the angle at which the screen is placed must be varied for each of the three negatives so that there shall be a progressive difference of 30°. Thus, one is to be 15°, the next 45°, and the third 75°. Mr. Geddes states two disadvantages which arise from *not* varying the angle of the screen. First, imperfect register, and second, the *moiré antique* effect. But there is a third, the necessity for very careful adjustment; and this not only in regard to the negatives but in two other respects not generally, if at all, considered, and in which the relationship of the angular conditions are probably never preserved. The first is the placing of the negatives to print by contact on the coated sensitized zinc or copper plates, and second, the perfectly accurate mounting and planing up after the etching and finishing.

When all these points are considered, there is no question but that trichromatic work by screen-made photo-blocks is both complicated, expensive, and more or less imperfect—often, indeed, very imperfect and unpleasing, not merely from the predominance of the red, but from muddiness of colour, due no doubt to the dots of each colour not properly registering, and therefore overlapping irregularly. The wonder is that any good work is done. The output of really presentable work is, up to the present, extremely scanty. Good results are decidedly the exception, not the rule, and are due greatly, there is little doubt, to highly-skilled engraver's work on the blocks.

Compared with the complication of the Screen Trichromatic Block method, and its uncertainties of result, the Dallastint Natural Grain Trichromatic Block method is simplicity itself and reliability. The natural grain, resembling as it does aquatint, not only lends itself to rendering gradations of colour without mechanical texture, but prevents slight imperfections in register from showing offensively. Indeed, a slight shifting of the register can be used in an effective manner if desired.

As regards simplicity in the Dallastint method, it starts from the very foundation—the production of the negatives. With the exception of using the necessary colour filters the negatives are taken in the usual manner either on dry plates, collodion emulsion or wet collodion. No reversed negatives are required for Dallastint blocks, except in the very rare case where the print has to appear reversed. No expensive screen, prism or reversing mirror is required, though the well-equipped taker of negatives for other purposes may find them useful.

The advantage of being able to use the original unsophisticated negative—rectified blemishes excepted—is obviously preferable to having a negative to which instead of its natural gradation and correct rendering of the texture and detail of the original has been added a mechanical texture which skilful, wonderful, and worthy of all praise as has been the development of the production and use of the screen, can never have the same pleasing artistic effect in print, as a well selected natural grain.

From the foundation simplicity obtained by using unsophisticated negatives the production of the Dallastint blocks is more simple also in the subsequent operations than by the methods more chiefly in use, whether for colour or monochrome. There is the same possibility of being able to work on the blocks as in the screen method and even with greater effect.

DUNCAN C. DALLAS.

October 31st, 1902.

General Notes.

COACHBUILDING PRIZES. — The Company of Coach Makers and Coach-harness Makers of London offer the following prizes for competition among British subjects engaged in the trades of coach making and coach-harness making and members of drawing and technical classes in connection with such trades, resident in the United Kingdom of Great Britain or Ireland. Competition No. 1.—Open to teachers of technical classes and previous prize winners in the Company's competitions—For drawings of a cab-shaped Victoria without sham door, on Cee and under springs, side elevation and half plan, not shaded; scale four inches to the foot, on paper 6 feet by 4 feet 6 inches; 1st prize, the Company's silver medal and £6; 2nd prize, the Company's bronze medal and £3. No. 2.—Open to all, except teachers and previous first-prize winners—For drawings of a square-shaped Landau, on elliptic springs, side elevation, half back and half plan, not shaded; scale one inch and a half to the foot, on one piece of paper 24 inches by 18 inches; 1st prize, £5 5s.; 2nd prize, £2 2s.; 3rd prize, £1 1s. No. 3—For side view drawings of a Hansom Cab, on two wheels, with improvement in front windows; details to be shown by a separate sketch on the same paper; scale three inches to the foot, on one piece of paper 6 feet by 4 feet 6 inches; 1st prize, £3 3s.; 2nd prize, £2 2s.; 3rd prize, £1 1s. No. 4.—For a set of drawings on three sheets of paper, 24 inches by 18 inches each, of a single harness for a horse 16 hands high, showing general or side view, front view of the saddle, bridle, and collar, and such details of the strapping and furniture as may be necessary, showing the number of stitches to the inch; scale at the discretion of the competitor; 1st prize, £3 3s.; 2nd prize, £2 2s. No. 5.—The Company offer a silver and bronze medal and the Master, Mr. Alderman Elam, offers £10 10s. to be divided as follows:—For a design for a Motor Car to carry four persons, side view, and front and back views; scale three inches to the foot, on one sheet of paper 6 feet by 4 feet 6 inches; the general design is the main feature; no details of machinery are required beyond what would be visible on the drawings asked for; 1st prize, the Company's silver medal and £6 6s.; 2nd prize, the Company's bronze medal and £4 4s. Nos. 3, 4 and 5 are open to all. The prize winner in any of the competitions, if not already free of the Company, may have the honorary freedom conferred upon him, should his drawing or essay in the opinion of the judges deserve it. Students of technical classes who may desire to exhibit models of carriages or parts of carriages can do so, and if they have sufficient merit, the judges may award medals or money prizes at discretion. Drawings to be delivered free at the hall of the Company, Noble-street, St. Martin's-le-Grand, London, on or before the 30th day of April, 1903.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 10...Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Arthur Vernon.

London Institution, Finsbury-circus, E.C., 5 p.m. Sir Robert S. Ball, "The Earth's Beginning."

TUESDAY, Nov. 11...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. C. Hopkinson, Bertram Hopkinson, and Ernest Talbot, "Electric Tramways."

Photographic, 66, Russell-square, W.C., 8 p.m. Messrs. Lumière and Seyewetz, "The Fading of Prints in Chloro-Citrate of Silver Paper Toned and fixed in a Combined Bath."

Colonial, Whitehall-rooms, Whitehall-place, S.W. 8 p.m. The Hon. T. A. Brassey, "Some Steps to Imperial Federation."

Geographical, University of London, Burlington-gardens, W., 3½ p.m. Col. Sir Thomas Holdich. "The Patagonian Andes."

THURSDAY, Nov. 13...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. H. Hadow, "Style and Character in Musical Composition."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Mr. James Swinburne.

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FRIDAY, NOVEMBER 14, 1902.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-ninth Session will be held on Wednesday Evening, the 19th of November, when an Address by SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., Chairman of the Council, will be delivered.

Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

NOVEMBER 19.—Opening Address of SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., Chairman of the Council.

NOVEMBER 26.—"Le Tunnel du Simplon, et la nouvelle ligne de chemin de fer directe Anglo-Italienne pour l'Orient." By Dr. GUSTAVE GOEGG, Professor of Technology at the High School of Commerce, Geneva. (The paper will be in French.) SIR WILLIAM H. PREECE, K.C.B., F.R.S., Chairman of the Council, will preside.

DECEMBER 3.—"Some Aspects of Photographic Development." By ALFRED WATKINS. SIR WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., will preside.

DECEMBER 10.—"French Rural Education and its Lessons for England." By CLOUDESLEY BRERETON. LORD REAY, G.C.S.I., G.C.I.E., Chairman of the London School Board, will preside.

DECEMBER 17.—"The South Russian Iron Industry." By ARCHIBALD P. HEAD, Mem.Inst.C.E. MR. WILLIAM EGERTON HUBBARD will preside.

INDIAN SECTION.

DECEMBER 11.—"Domestic Life in Persia." By MISS ELLA C. SYKES. EARL PERCY, M.P., Under Secretary of State for India, will preside.

For Meetings after Christmas :—

"Industrial Trusts." By PROF. W. SMART, LL.D. SIR ROBERT GIFFIN, K.C.B., LL.D., F.R.S., will preside.

"Oil Lighting by Incandescence." By ARTHUR KITSON.

"The Metric System." By A. SONNENSCHEIN.

"The Cost of Municipal Trading." By DIXON H. DAVIES.

"Stage Costumes and Accessories." By PERCY MACQUOID.

"The Principles of Applied Art." By G. F. BODLEY, R.A.

"English Silks." By FRANK WARNER.

"Modern Movements in Decorative Art." By CHARLES HOLME.

"British North Borneo." By HENRY WALKER, Commissioner of Lands, British North Borneo.

"Three Colour Printing." By HARVEY DALZIEL.

"The Port of London." By Dr. B. W. GINSBURG.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at 4.30 o'clock :—

December 11, January 22, February 12, March 12, April 23, May 14.

COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 o'clock :—

January 13, February 24, March 31, May 5.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesdays, at 4.30 or 8 o'clock :—

January 20, February 3, 17, March 17, April 21, May 19.

CANTOR LECTURES.

The following courses of Cantor Lectures will be delivered on Monday Evenings, at 8 o'clock :—

PROF. VIVIAN B. LEWES, "The Future of Coal Gas and Allied Illuminants." Four Lectures.

LECTURE I.—NOVEMBER 24.—The effect of the last twenty years on the manufacture of coal gas—High illuminating power *versus* low-grade gas—The methods available for the economic production of low-grade gas—The effect of temperature on carbonisation.

LECTURE II.—DECEMBER 1.—The dilution of coal gas by gases cheaply produced by other processes—The effect of lowering candle power on the calorific value of the gas—The photometry of low-grade gas and the conditions under which its illuminating power is best developed.

LECTURE III.—DECEMBER 8.—The relation of the candle-power and calorific value of gas to its use with the incandescent mantle—The incandescent mantle and the directions in which it will be improved—The probable future of coal gas.

LECTURE IV.—DECEMBER 15.—Lighting by oil and the advances of the past fifty years—The use of oil in incandescent mantle lighting—Vapour burners and their future—Air gas and its latest developments —The present position and future of acetylene.

JULIUS HÜBNER, "Paper Manufacture." Four Lectures.

February 2, 9, 16, 23.

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "Hertzian Wave Telegraphy in Theory and Practice." Four Lectures.

March 2, 9, 16, 23.

W. WORBY BEAUMONT, Mem.Inst.C.E., "Mechanical Road Carriages." Four Lectures.

April 27, May 4, 11, 18.

JUVENILE LECTURES.

Two lectures suitable for a juvenile audience will be delivered on Wednesday evenings, December 31 and January 7, at five o'clock, by Professor EDWARD B. POULTON, M.A., D.Sc., F.R.S. (Hope Professor of Zoology in the University of Oxford), on "Means of Defence in the Struggle for Life among Animals."

LECTURE I.—DECEMBER 31.—"The Methods by which Animals hide in order to escape their Enemies and catch their Prey."

LECTURE II.—JANUARY 7.—"The Ways in which Animals warn their Enemies and signal to their Friends."

ADDRESSES OF MEMBERS.

Members will have noticed that the addresses on the wrappers of the present and last week's numbers of the *Journal* are printed in a different manner to the old method. It can hardly be hoped that the alteration has been effected without a certain number of errors in individual addresses. The Secretary, therefore, will be grateful if members will let him have notice of any mistakes which may exist in their addresses as printed on the wrapper of the present issue.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section Committee was held on Wednesday afternoon, 12th inst. Present:—Sir Westby P. Perceval, K.C.M.G., in the chair; Lord Belhaven and Stenton, Sir John A. Cockburn, K.C.M.G., Hon. Henry Copeland, Edward Dent, Robert Kaye Gray, Alexander Siemens, and Sir Frederick Young, K.C.M.G., with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, Secretary of the Section.

The arrangements for next session were considered.

BRAZILIAN DIAMONDS AND CARBONS.

Diamonds are said to have been first found, in the State of Bahia, in 1821, in the range of mountains known as Serra do Sincorá, but not until 1844—when José Pereira do Prado, who was travelling from that region to Bahia City, and camped for the night on the bank of the Mocuge, a small tributary to the Paraguaçu River, and there, by accident, found a quantity of diamonds—was any impetus given to mining for the precious stones. As soon as it became known that diamonds in quantity had been found, great numbers of people set out for that region, and at the site of the discovery, S. Joao do Paraguaçu, otherwise known as Santa Isabel, was founded, and has continued to be one of the chief diamond centres. The State divides the diamond region into fourteen districts, namely: Lençoes, Andarahy, Chique Chique, Santa Isabel Cravada, Chapoda Velha, Paraguaçu, Sincora, Lavrinha, Campestre, Morro do Chapeo, B'om Jesus, S. Ignacio, and Cannavieras, the region taking its name from the town which forms its centre. A better division would be into two sections in accordance with the geological formation and position—one in the centre of the State and tributary to the Paraguaçu River, and the other in the southern portions of the State along the Pardo River. By far the most productive section is that first mentioned under this classification. It has been almost continuously worked since the date of its discovery in 1844, and it continues to be productive, though the number extracted has of late been decreasing on account of the lack of tools and machinery. Prior to the discovery of the South African mines, this section was the greatest producer of diamonds, and prices were high, but the output in Africa tended to decrease interest in the Bahia mines.

According to Consul Furniss, of Bahia, diamonds are first encountered in the bed of the Paraguaçu River, 103 miles from Cachoeira, at a place called Joao Amaro. They are found from there up to the source of the river, but from Joao Amaro to Andarahy in very small quantities, doubtless due to the difficulty in mining them, as they seem to occur only in the river bed. The most productive area is in the foothills to the east of Serra das Labras Diamantines, particularly along the many small streams tributary to the Paraguaçu River, with the towns of Santa Isabel, Chique Chique, Andarahy, and Lençoes as centres. The geological formation of the region is very interesting, and shows that at some time in the history of the world, the mountains were thrown up by a hot mass of stone, and the diamonds there found are the carbon which by great heat and pressure crystallized. A considerable portion, for lack of proper conditions, failed to crystallize, and is now encountered in hard, blackish masses of irregular shape, known as carbon. The method of mining differs in the different sections. In the most productive one, the work is of two kinds: removing the surface disintegration and that in the gullies, crevasses, and beneath the more accessible stones, or mining by tunnels between the stones into the pockets of the mountains, and taking out the "cascalho" found there. Cascalho is the diamond and carbon-bearing material which consists of soil, sand, broken, or disintegrated stone. The cascalho is usually collected until towards the week's end, and is then labouriously washed, either by pouring the masses into sluices or of ditches of running water and agitating it with a hoe, or by placing small quantities in large wooden basins and washing it in water. In the first instance, the object is to wash the soil and heavier particles away, arrangements being made to impede the heavier masses, and consequently the diamonds and carbons. The part remaining is carefully washed in the large wooden basins and the rocks picked over by hand. The miners are so accustomed to the appearance of the desired stones, that in spite of the facts that there are ordinary stones which closely resemble them, they can wash and finally sort a very large quantity of diamond-bearing material in a short time. The other method of mining consists in diving to the bottom of the river-bed and removing the silt, sand, gravel, &c., as far as the layer of clay or stone beneath. This system is carried on mostly in the Paraguaçu River from a point midway between Bandeira de Mello and Andarahy to Joao Amaro. The centre of this kind of work is near the village of Tamandoa. Here are located six diving machines, and besides the machine divers, there are about twenty men who dive naked into the more shallow places, and this number is increased to about one hundred in the dry season, and to even a greater number when the periodical droughts arrive. Although there are perhaps as many as 5,000 people who work more or less in the mines, they do not work systematically, and only endeavour to take out such cascalho as can be easily removed. Their only implements are a hoe, a crowbar, a hook-shaped piece of metal about two fingers in width and about eight inches long, mounted on a pole three or four feet in length, sometimes a hammer and a hand-drill and two wooden basins, one of small size to carry the cascalho to the water's side, and a large basin with which to wash. Now and then ordinary powder is used to remove a refractory ledge of rock.

According to law, all diamond and carbon-bearing lands belong to the State. It is possible for a person of any nation to take out a claim, by complying with the regulations. These require a claimant to make a general description in writing of the portion desired —which may be not more than 578,864 square yards, or less than 34,732 square yards—and to file application for the same at the office of the director of diamond mines at Lençoes. Anyone mining without a license or lease, subjects tools, and such stones as may be found, to confiscation; the State giving one half of the value of the confiscated property to he informer. Besides the claims leased in the regular way, there are various concessions which have been granted by the State to private persons and companies, but in all cases to Brazilians, except one concession to a French company at Cannavieras. In the Paraguaçu region there are six such concessions, which differ in size, but average about nine square miles, and from which the State receives sums varying from £25 to £380 a year. In each town of the mining district there are buyers who represent the five Bahia City firms which are in the carbon and diamond business. These buyers are furnished with large quantities of money, and are advised by each mail and frequently by special messenger as to the highest price they can give, these prices being regulated by cable from abroad. While the prices in the main are even, there is often competition for a good specimen, and a miner usually goes the rounds and sells to the one offering the best price. The output of carbons for the district now averages about 2,500 carats a month. Unless there are improvements in mining and modern methods, and machinery are introduced, the output will undoubtedly decrease year by year while the demand is constantly increasing. Immense quantities of carbons are there, but it will take well directed companies with large capital to take them out, and there are little chances for small operators. Carbons are classified as porous, or crystalline and good. The first variety is being bought from the miner at the present time at half the price of the good stones which sell at £5 per carat if the stone is larger than three-fourths of a carat, and at thirty shillings per carat for stones of from one half to three-fourths of a carat, with which are mixed globular diamonds. For very large carbons the price is usually a small amount less per carat, as these have to be broken up for the trade. The largest carbon ever encountered was found in the Lençoes district in 1895 on the ledge of a mountain which had been worked some time before. It weighed 3,150 carats, and was purchased from the miner for

£3,200, one fourth of the price going to the owner of the claim upon which it was found. This stone frequently changed hands, and was finally purchased by a Bahia city exporter for £5,080, and was shipped to Paris, where it was broken up into marketable pieces.

The diamonds found in the Paraguaçu are not so clear and perfect as those found about Cannaviriras, but are said to have more brilliancy. They occur in conjunction with the carbons, and frequently contain small particles of uncrystallized carbon, which materially lessens their value. They are classified by the buyers at the mines into "bons," "fazenda," "fira," "melle," "vitriar," and "fundos." In the Cannaviriras district diamonds were discovered in 1881. This region is reached from Cannaviriras—on the coast south of Bahia city—by ascending the Prado River fifty-six miles in canoes to Jacarandá, and from there taking mules to Salobra, twelve miles higher up the same river. The diamonds are said to be found only in the river bed and the land directly adjacent thereto. It is impossible to state with definiteness the diamond and carbon output of the Bahia district, as no statistics are available, and not even the figures given for the exports can be taken as correct. There is an export tax of 13 per cent., and many stones must leave the country without paying duty, as the amount given as collected for diamonds and carbons is not equal to the carbon output alone, and all the carbons are exported. At the present time almost all of the diamonds are being exported uncut, as there is no local market for cut stones, and the work is not sufficiently well done to make them saleable abroad. In the diamond regions there are several factories, and one is also situated in Bahia city.

PROPOSED BRIDGE ACROSS THE STRAND.

Sir John Wolfe-Barry has submitted to the Westminster City Council a scheme for the construction of a bridge across the Strand at the bottom of Wellington-street, so as to enable the north and south traffic to pass independently of the east and west traffic. He explained to the Committee that the traffic had greatly increased since he made this proposal in his address to the Members of the Society of Arts (see *Journal*, vol. xlviii., p. 13).

Sir John Wolfe-Barry's solution of the problem is to make a street adjoining Wellington-street on its western side, starting from Tavistock-street, which would rise from that point to a gradient of about 1 in 30, to construct a bridge across the Strand with a headway of about 16 ft. 6 in., and to continue the roadway on the line of Lancaster-place, which should fall at a gradient of about 1 in 20 to 1 in 30 and join Waterloo-bridge at its northern end. He suggested that Wellington-street should remain as at present with a width of 50 ft., and that the new street should also have a width of 50 ft., the two streets running side by side at different levels. The scheme would permit of the building of shops along a considerable portion of the west side of Wellington-street, below the new street, and along the raised road there would also be a frontage of commercial value which would be of great importance in connection with the expense of the project. The Highways Committee of the London County Council have reported upon this question, which was referred to them at the beginning of the year. The Committee takes objection to the scheme because if a bridge with inclined approaches were constructed from Wellington-street to Waterloo-bridge it would be necessary to remove the western steps of Waterloo-bridge, and to carry the approach to the first abutment of the bridge, with the result that even then the gradient would be as steep as 1 in 20. This could be improved to 1 in 30 if the inclined road were extended to a considerable distance on to Waterloo-bridge, involving a widening of the northernmost span of the bridge. This widening could not be carried out by merely widening the arch, but would necessitate a girder span over the Victoria-embankment, unless the bridge were widened for its entire length across the river. It would be necessary to widen Wellington-street and to place the inclined approach in the middle of the widened thoroughfare, because if the inclined approach were placed on one side of the street one line of the traffic using the approach would, upon reaching Waterloo-bridge, have to cross one line of the traffic passing on a level to the Strand, with the result that the construction of the bridge would do little more than tend to remove from the Strand the congestion caused by cross traffic to the point where the inclined approach delivered on to Waterloo-bridge. With respect to the construction of a subway for general traffic from Southampton-row under Holborn, it is stated that it would not only involve considerable interference with the projected tramway-subway scheme, but would also make it necessary either to syphon the Fleet sewer in Holborn or to divert the sewer at considerable expense. The Highways Committee feel that they have no alternative at the present moment but to advise that the question of the construction of a subway or bridge at the junction of the Strand with Wellington-street, and at the junction of Holborn with Southampton-row, should be postponed until after the formation of the new street from Holborn to the Strand.

Obituary.

Sir Alexander Mackenzie, K.C.S.I.—Sir Alexander Mackenzie, late Lieutenant-Governor of Bengal, died on Monday, 10th inst. He was the eldest son of the Rev. J. R. Mackenzie, D.D., f Birmingham, and was born at Dumfries, 29th une, 1842. He was educated at Edward VI.'s Grammar School, and at Trinity College, Cambridge. He was appointed to the Bengal Civil Service in 1861, and became Secretary to the Bengal Government in 1877, to the Government of India, Home Department in 1882, Chief Commissioner of the Central Provinces in 1887, of Burmah in 1890, member of the Governor-General's Council in April, 1895, and Lieutenant-Governor of Bengal in December of the same year; from which office he retired owing to ill-heath in 1898. The *Times*, in its obituary notice of Sir Alexander Mackenzie, draws attention to his distinguished services to the State, more particularly in respect to preparations for the relief of famine and protection from plague—"he is justly entitled to the credit of having greatly improved the sanitary condition of the capital of Bengal and of India, a matter of urgency even before plague appeared in Bombay in 1896." Sir Alexander was elected a member of the Society of Arts in 1898.

Notes on Books.

THE ARGENTINE YEAR BOOK, 1902. Buenos Aires: John Grant and Son; London: Moorgate Publishing Company.

This is a volume of over five hundred pages, containing a large amount of information respecting the Government, finance, trade and commerce, railway companies, climate, &c., of the Argentine Republic. A short Chronology is prefixed to the description of the present condition of the Republic. The volume contains illustrations of some of the chief public buildings.

THE INFLUENCE OF AGE AND STUDY ON EYESIGHT IN GENERAL AND MYOPIA IN PARTICULAR. By S. V. Ramaswamy Iyengar, M.D. Bangalore, 1902.

Dr. Iyengar has tested the sight of 4,654 pupils, of whom 612 were girls, and he found subnormal vision in more than 40 per cent. of the number, or, exactly, in 45·91 per cent. of the boys, and in 42·81 per cent. of the girls. His results are analysed in different ways; and he appends to the general statement of them an account of the principal causes of defective sight, of their relative importance, and of the means by which the incidental evils may be kept at the lowest point. In this he traverses ground which has often been traversed in England, but it is satisfactory that an Indian physician should be thus active in calling the attention of his compatriots to a question which is too apt to be neglected, and in explaining to parents and teachers the effect which neglect of the sight in childhood may exert upon its future quality.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 17...British Architects, 9, Conduit-street, W., 8 p.m. 1. Dr. F. C. Penrose, "The Ionic Volute." 2. Dr. A. S. Murray, "Fragment of the Parthenon Frieze."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. T. Reed (of *Punch*), "Caricature In and Out of Parliament."

TUESDAY, Nov. 18...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper, "Electric Tramways."

Statistical (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C. Annual Address by the President, Major Patrick George Craigie.

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. A. Smith Woodward, "Some Pliocene Mammalian Remains from Concud." 2. Mr. F. E. Beddard, "Birth of an Indian Elephant at the Society's Menagerie." 3. Mr. R. Lydekker, "Note on the Cabul Markhor."

Designers, Clifford's-inn, Fleet-street, E.C., 8 p.m. Mr. Philip H. Newman, "Pageantry and Art.'

WEDNESDAY, Nov. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C, 8 p.m. Address by the Chairman of Council, Sir William H. Preece, and presentation of Medals.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. F. Campbell Bayard, "English Climatology, 1881-1900." 2. Mr. C. V. Bellamy, "The Rainfall of Dominica."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Dr. Philip E. Shaw, "An Electrical Method of taking Microscope Measurements." 2. A demonstration by Dr. Dukinfield H. Scott, "The Microscope in Fossil Botany." 3. A demonstration by Dr. Edmund J. Spitta.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-st. W., 8 p.m.

Chemical, Burlington-house, W., 5½ p.m. Papers by Messrs. J. E. Reynolds and E. A. Werner; F. S. Kipping; W. H. Perkin, jun., and Miss E. Smith; A. G. Perkin and C. R. Wilson; S. Young and Miss E. C. Fortey; S. Young; E. Rutherford and F. Soddy; and Miss M. A. Whiteley.

THURSDAY, Nov. 20...Royal Burlington-house, 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Sidney Vines, "Digestion in Plants." 2. Mr. A. G. Tansley, "Relation of Hiotogensis to Tissue-Morphology." 3. Mr. L. A. Boodle, "Stellar Structure of Schizaea and other Ferns."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. J. R. Harris, "Early Christian Documents."

Historical, Clifford's-inn-hall, Fleet-st., E.C., 5 p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

United Service Institution, Whiteball, S.W., 3 p.m.

Mining and Metallurgy, Geological Museum. Jermyn-street, S.W., 8 p.m. 1. Mr. E. F. Heneage, "Diamondiferous Deposits in South Africa." 2. Mr. Ernest R. Woakes, "Concentration Plant for Silver-Lead Ore." 3. Mr. C. M. P. Wright, "Cyaniding Concentration by Percolation."

FRIDAY, Nov. 21...The Institution of Junior Engineers, Westminster Palace Hotel, 8 p.m.

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 8 p.m. 1. Discussion upon "Oil Motor Cars of 1902." 2. Mr. J. N. S. Williams, "Raw Cane Sugar Manufactories in the Hawaiian Islands."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of Transactions of Societies and other Periodicals.

TRANSACTIONS, &c.

American Academy of Arts and Sciences, Proceedings.
American Academy of Political and Social Science, Annals.
American Chemical Society, Journal.
American Institute of Architects, Bulletin.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Proceedings.
Architectural Association, Notes.
Association of Engineering Societies (American), Journal.
Australasian Association for the Advancement of Science, Report.
Bath and West of England Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
British Guiana, Royal Agricultural and Commercial Society, Journal.
British Horological Institute, Horological Journal.
Brussels, Société d'Etudes Coloniales, Bulletin.
———, Travaux Publics de Belgique, Annales.
Camera Club, Journal.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Patent Office, Record.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Proceedings.
Chemical Society, Journal.
Chicago, Western Society of Engineers, Journal.
———, Field Columbian Museum, Publications.
Cleveland Institution of Engineers, Proceedings.
Cold Storage and Ice Association, Proceedings.
Cornell University, Physical Review.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Glasgow Philosophical Society, Proceedings.
Haarlem, Koloniaal Museum, Bulletin.
Imperial Department of Agriculture for the West Indies, Publications.
Imperial Institute, Journal.
Incorporated Gas Institute, Transactions.
India, Geological Survey, Memoirs and Palæontologia Indica.
———, Government of, Agricultural Ledger.
Indian Meteorological Department, Report.
Institute of Actuaries, Journal.
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Institution of Civil Engineers, Minutes of Proceedings.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland Transactions.
Institution of Junior Engineers, Record of Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
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Iron and Steel Institute, Journal.
Japan, College of Science, Imperial University, Journal.
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Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
London Chamber of Commerce, Journal.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Manchester Steam Users' Association, Reports.
Massachusetts Institute of Technology. Annual Catalogue.
Munich, Polytechnischer - Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Association for the Promotion of Technical and Secondary Education, "Record."
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Nederlandsche Maatschappij ter Bevordering van Nijverheid, Tijdschrift.
New South Wales, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Memoirs.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Science, Transactions.
Paris, Comité International des Poids et Mesures. Procès Verbaux.
———, Conservatoire National des Arts et Metiers, Annales.

Paris, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Geographie Commerciale, Bulletin.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Bulletin.
Patent Agents, Chartered Institute of, Transactions.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Pharmaceutical Society, "The Pharmaceutical Journal."
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Royal Agricultural Society, Journal.
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Royal Scottish Society of Arts, Transactions.
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Royal United Service Institution, Journal.
Sanitary Institute, Journal.
Smithsonian Institution, Report and Publications.
Société Ramond, Bulletin.
Society of Antiquaries, Archæologia and Proceedings
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
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South African Association of Engineers, Proceedings.
South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.
Wisconsin Academy of Sciences, Arts, and Letters, Transactions.

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Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Machinist.
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Athenæum.
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Board of Trade Journal.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
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Chronique Industrielle.
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Oils, Colours, and Drysalteries.
Photographic Chronicle.
Photographic News.
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Produce Markets' Review.
Public Health Engineer.
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Finance Chronicle.
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Jeweller and Metalworker.
Moniteur des Produits Chimiques
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Cabinet Maker and Art Furnisher.
Caterer and Refreshment Contractors' Gazette.
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